Submitted to:
US EPA Region 8
Denver, CO

Submitted by:
Atlantic Richfield Company
La Palma, CA
May 31, 2013

2013 Supplement to the Field Sampling Plan

Rico-Argentine Mine Site – Rico Tunnels
Operable Unit OU01
Rico, Colorado

Atlantic Richfield Company

Anthony R. Brown
Project Manager, Mining

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May 31, 2013

VIA EMAIL AND HAND DELIVERY

Mr. Steven Way
On-Scene Coordinator
Emergency Response Program (8EPR-SA)
US EPA Region 8
1595 Wynkoop Street
Denver, CO 80202-1129

Subject: 2013 Supplement to the Field Sampling Plan
Rico-Argentine Mine Site – Rico Tunnels
Operable Unit OU01 Rico, Colorado

Dear Mr. Way,

A digital file in PDF format of the 2013 Supplement to the Field Sampling Plan, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado, dated May 31, 2013, is being submitted to you today via email. Three (3) hard copies of the report will also be hand-delivered to your office no later than June 3.

Atlantic Richfield Company (AR) is submitting this report responsive to requirements in Tasks B, C, and F of the Remedial Action Work Plan accompanying the Unilateral Administrative Order for Removal Action, Rico-Argentine Site, Dolores County, Colorado, U.S. EPA Region 8, Docket No. CERCLA-08-2011-0005.

If you have any questions or comments, please feel free to contact me at (714) 228-6770 or via email at Anthony.Brown@bp.com.

Sincerely,

Anthony R. Brown

Tony Brown
Project Manager
Atlantic Richfield Company

Enclosure (2013 Supplement to the Field Sampling Plan)

cc: Terry Moore, Atlantic Richfield
Jerry Johnson, Atlantic Richfield
Chris Sanchez, AECI
Sandy Riese, EnSci
Dave McCarthy, Copper Environmental
Tom Kreutz, AECOM
Doug Yadon, AECOM
Steve Szocik, AECOM
Marc Lombardi, AMEC

2013 Supplement to the Field Sampling Plan

Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01 Rico, Colorado

May 31, 2013

Prepared for:

Atlantic Richfield Company
La Palma, CA

For submittal to:

US EPA Region 8
Denver, CO

Thomas M. Kreutz
Thomas M. Kreutz, PE
AECOM Project Manager

Douglas M. Yadon
Douglas M. Yadon, PE
Certifying/Design Engineer

Stephen Szocik
Steve Szocik
QA Manager

Title and Approval Sheet

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TABLES

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ATTACHMENTS

DOCUMENT CONTROL LOG

Revision #	Prepared by	Reviewed by	Approved by	Date	Pages Affected
0	D. Yadon; E. Drumright; C. Sanchez	T. Brown, T. Moore, S. Riese, J. Johnson, S. Archer	T. Brown	5/31/2013	NA

DISTRIBUTION LIST[1]

Revision #	Name	Organization
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0	Sandy Riese	EnSci
0	Dave McCarthy	Copper Environmental
0	Marc Lombardi/Spencer Archer	AMEC
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0	Doug Yadon	AECOM
0	Steve Szocik	AECOM

[1] Distribution in digital format unless noted otherwise.
[2] One hard copy sent.

1.0 Project Management

1.1 Project/Task Organization

AECOM Technical Services, Inc. (AECOM), in cooperation with Anderson Engineering Company, Inc. (AECI), and on behalf of Atlantic Richfield Company (AR), has prepared this 2013 Supplement to the Field Sampling Plan (FSP) for investigation activities at the St. Louis Ponds system. This document supplements two prior investigation plans (Atlantic Richfield Company, 2012; Atlantic Richfield Company, 2011a). The work is to be performed in the area of the St. Louis Ponds, north of Rico, Colorado, within Dolores County at the Rico Tunnels Operable Unit OU01 of the Rico-Argentine Mine Site (Site) as shown on Figure 1.

The purpose of this section is to define the areas of responsibility and lines of authority for each organization and for the members of the FSP team to facilitate decision-making during completion of the work.

The project management organization is presented on Figure 2, with the responsibilities of key team members described in the following sub-sections.

1.1.1 Regulatory/Permitting Agency

The U.S. Environmental Protection Agency (EPA) is responsible for overseeing AR's performance of work for consistency and compliance with the provisions of the EPA Removal Action Work Plan (RAWP; EPA, 2011a) and the Unilateral Administrative Order for Removal Action (UAO; EPA, 2011b). EPA's designated On-Scene Coordinator (OSC) is Mr. Steve Way. The EPA or its oversight contractor will periodically be on-site during investigation activities.

1.1.2 Facility Owner

AR has the responsibility for implementing the work described in this 2013 Supplement to the FSP. AR will coordinate overall management and implementation of the St. Louis Ponds area investigation activities.

AR is responsible for complying with the UAO and has the authority to select and dismiss subcontractors for completion of the investigation. AR also has the authority to accept or reject plans and reports, recommendations of the Investigation Field Manager, and the materials and workmanship of the various subcontractors who may work on the Site.

1.1.2.1 Project Manager

Mr. Tony Brown is AR's Project Manager. Mr. Brown will be AR's key contact person for the EPA during the work. The Project Manager will also:

- Review and sign submittals and progress reports or authorize others to sign submittals and progress reports on his behalf.

- Certify that the investigation has been completed in accordance with the approved 2013 Supplement to the FSP.

- Sign the Geotechnical Investigations Data Report (in addition to the AECOM Certifying/Design Engineer).

1.1.3 Investigation Field Manager

Mr. Christopher Sanchez, CSP (AECI), will serve as the Investigation Field Manager. The duties of the Investigation Field Manager include:

- Report to the AR Project Manager and/or his on-site representative and to the Certifying/Design Engineer.

- Identify and coordinate scheduling of drilling and geophysical subcontractors, and the geophysical survey team member from AECOM.

- Oversee on-site investigation activities, including engineering geologic mapping and grab sampling, soil/rock boring, sampling and logging, and geophysical surveying.

- Chair on-site project meetings related to the investigation work.

1.1.4 Certifying/Design Engineer

Mr. Douglas M. Yadon, PE (AECOM), will serve as the Certifying/Design Engineer. The Certifying/Design Engineer is responsible for preparation of the final report resulting from the investigation work. In addition, the Certifying/Design Engineer or his designee will be responsible for:

- Selection of the number and location of borings, the type of sampling and depth of investigation at borings, design and installation of piezometers and/or monitoring wells, and the type and location of geophysical surveys.

- Periodic observation of the investigation work to assure that the work is in agreement with the intent of the 2013 Supplement to the FSP and the anticipated design requirements.

- Direction of reduction, interpretation, and analysis of field and laboratory geotechnical data.

- Direction of the preparation of the laboratory testing program based on investigation results, and selection and oversight of the geotechnical laboratories.

- Inclusion of the supplemental field test results in the 2013 Geotechnical Investigations Data Report.

- Participate in key technical discussions with EPA, AR, AECI, and other project team members and subcontractors.

1.1.5 Health and Safety Officer

Mr. Christopher Sanchez, CSP (AECI), or his appointed designee will serve as the Site's Health and Safety Officer (HSO). The HSO will ensure that all Health and Safety Plan (HASP) requirements are effectively employed and enforced during investigation activities completed on-site.

1.1.6 Subcontractors

The drilling and geophysical subcontractors for this 2013 Supplement to the FSP will be identified and contracted by AECI with input and concurrence by AECOM and final authorization by AR. *The geotechnical laboratories for this 2013 Supplement to the FSP will be identified and* contracted by AECOM and AECI, with final authorization by AR. Information regarding the task specific Subcontractors will be provided to the EPA as those subcontractors are selected. The subcontractors will be responsible for supplying materials and labor to complete the investigation in reasonable conformity with the requirements of this 2013 Supplement to the FSP. As such, each subcontractor will be responsible for quality control (QC) to ensure that the work meets the requirements of this 2013 Supplement to the FSP. Quality Assurance (QA) for field activities and for work by any geotechnical laboratory contracted by AECI will be the responsibility of AECI. AECOM will be responsible for QA for any work performed in AECOM's geotechnical laboratory and for work by any geotechnical laboratory contracted by AECOM.

AECI, on behalf of AR and AECOM, will be responsible to ensure that all necessary EPA approvals, authorizations, and coordination for EPA oversight have been secured or arranged before any work at the Site is performed by any subcontractor.

The subcontractors will immediately notify their respective QC Officers of any unanticipated conditions encountered during the investigation that in their opinion differ materially from those anticipated based on the scope of work prepared by AECI or otherwise communicated to the subcontractors by AECI. The QC Officer shall in turn notify the Investigation Field Manager for any concurrence or direction to respond to the unanticipated condition(s). The Investigation Field Manager will receive input from the Certifying/Design Engineer in matters that will or could affect the integrity of the analyses or designs to be based on the results of the field investigation program, and from the Quality Assurance (QA) Manager on matters affecting the quality and integrity of the information being developed during the investigation.

1.1.7 Quality Assurance (QA) Manager

Mr. Steve Szocik of AECOM will serve as the project QA Manager. He will remain independent from all team members generating data or performing data analyses or evaluations for work under this 2013 Supplement to the FSP, including AECOM, AECI, and subcontractors' staff, to ensure the integrity of the quality assurance functions. Mr. Szocik will oversee the QA procedures and maintain the QA file for the project as described further in various sections herein. This will include issuing revisions to QA procedures if/as necessary and appropriate over the course of the project. He will interface with subcontractor QC Officers through the Investigation Field Manager.

1.1.8 Quality Control (QC) Officers

Each subcontractor will designate a QC Officer. The QC Officer is responsible for:

- Performing observations and field and/or laboratory tests to verify that:
  - Regular calibration of investigation equipment is properly conducted and recorded.
  - The investigation equipment, personnel, and procedures do not change over time or that any changes are managed and documented properly (MOC process, etc.) and do not adversely impact the investigation process.
  - The boring and geophysical sampling/surveying and laboratory test data are accurately recorded and maintained.
- Identifying deficient work items and recommending corrective actions.
- Ensuring that agreed-upon corrective actions have been conducted and are sufficient to correct the deficiency.

Planned and actual locations for borings, piezometers/monitoring wells, test pits, and geophysical survey lines will be surveyed by AECI in an accurate and timely manner.

1.2 Problem Definition and Background

The work described in this supplement is required to fill identified data gaps summarized below in Section 1.3 related to final siting and design of the various facilities that may be required to be constructed or enhanced as part of the overall water treatment system at the Site. The facilities to be further investigated in 2013 include the former Pond 19 Area, a treatment solids drying facility, potential long-term solids repository sites, and existing pond peripheries and sub-bottoms in the St. Louis Ponds system. Borings for soil/bedrock sampling and monitoring well installation for geotechnical purposes in support of evaluations and design of hydraulic controls at the St. Louis Tunnel are covered under a separate 2013 Supplement to the Investigation Plan for Collapsed Adit Area at St. Louis Tunnel (Atlantic Richfield Company, 2013a).

The work includes: 1) detailed engineering geologic mapping; 2) completion of soil borings; 3) completion of test pits; 4) construction of monitoring wells for geotechnical purposes in selected soil borings; 5) sub-bottom geophysical sounding of accessible ponds; and 6) laboratory testing of selected samples acquired during the field investigation work. Much of the work to be implemented under this 2013 Supplement to the FSP will also support ongoing characterizations and evaluations by AMEC Environment & Infrastructure, Inc. (AMEC) under the Conceptual Site Model (CSM) development task.

1.3 Data Gaps

A very substantial amount of geologic and geotechnical field investigation and geotechnical laboratory testing have been performed at the St. Louis Ponds site for a variety of purposes by AR and others over the past more than 30 years. The work under this 2013 Supplement to the FSP is specifically focused to address the last identified geotechnical data gaps to support ongoing remedy selection and ultimately remedial design at the site. As discussed elsewhere in this document, some of the work planned will also support ongoing characterization and evaluations under the CSM. The geotechnical data gaps are summarized as follows, together with identification of CSM data gaps that are also addressed at least in part by the work under this 2013 Supplement to the FSP:

- More detailed surficial engineering geologic mapping of the St. Louis Ponds site is needed, together with the existing and planned subsurface data, to supplement interpretation of geologic and geotechnical conditions throughout the site in support of both the ongoing CSM characterizations and evaluations and ultimately design of solids management and water treatment remedies.

- Geotechnical conditions in the Pond 19 area need to be investigated to support evaluation and design of an expansion of the existing Pond 18 for additional system detention should an open pond lime treatment system be selected as the primary or a part of the water treatment remedy for the site. The planned borings will also provide additional information on calcines known to be present in this area in support of the CSM task.

- Some further field sampling and laboratory testing of subgrade and local borrow material at the potential South Stacked Repository – Option A site (SSR-A) is required to: 1) better estimate the shear strength of subgrade in the repository footprint; 2) assess interface strength between the subgrade and optional liner materials; and 3) evaluate the amount of potential oversize in and the as-compacted density and shear strength of the borrow available for starter dike and other ancillary earthwork construction.

- Geotechnical and groundwater conditions at the eastern periphery of and within the existing Pond 13 require additional focused field investigation and laboratory testing to better characterize the depth to groundwater within and beneath the pond and embankment, and to further define the extent and depth of solids and calcines within the pond above the alluvial subgrade.

- Additional field characterization of the presence, thickness, and volume of lime-addition treatment solids and calcines, and the depth to alluvial subgrade in all accessible water-filled ponds at the Site is necessary to support ongoing evaluation and design of solids management methods and facilities. This information will also support characterizations and evaluations related to potential metals loadings to groundwater from the ponds under the CSM task.

- Groundwater conditions and quality at three specific locations will be investigated in support of the CSM (see planned monitoring wells DG-1, -2, and -3 on Figure 4); see the forthcoming CSM Work Plan for additional discussion of this data gap and the planned monitoring wells.

1.4 Project/Task Description

The primary purpose of this 2013 Supplement to the FSP is to present a scope of work for supplemental subsurface geotechnical investigation and laboratory testing of the existing and potential new facilities noted above. These activities are responsive to addressing the data gaps summarized above in Section 1.3, thereby completing the investigative requirements under Tasks B, C, and F of the RAWP (EPA, 2011a). The results of this investigation will be used in the ongoing siting, selection, and design of alternative and/or supplemental sites for new facilities required as part of a lime precipitation water treatment system, should this technology ultimately be selected to treat mine adit discharge from the St. Louis Tunnel, and/or for permanent on-site storage of existing lime precipitation solids. This includes ongoing evaluation of Pond 13 as a site for temporary and possibly permanent storage/drying of solids to be removed in 2013 from Ponds 11 and 12, and possibly from Pond 14 in 2014. It also includes further investigation at the SSR-A site as one of the potential sites for drying and/or storage of the remaining approximately 2 feet of solids from Ponds 11, 12, 14, 15, and 18, if determined necessary based on evaluations of potential metals loading to the river via groundwater under the CSM task, following completion and full implementation of the Initial Solids Removal Plan (ISRP; Atlantic Richfield Company, 2011a) in 2014.

In addition to the geotechnical work described above, this scope of work includes further investigation by surface mapping and grab sampling and in-pond geophysical sounding to support CSM work to more thoroughly define the location, areal extent, and depth of calcines at the St. Louis Ponds site. This information will support ongoing evaluations as part of the CSM task of the effects of these deposits on groundwater quality, and if necessary, evaluation of remedial alternatives to address these deposits. The detailed engineering geologic mapping and sub-bottom geophysical sounding will also provide important information to support design of treatment wetlands (in addition to other investigations under the CSM task) should this technology be selected as the primary or a major component of a long-term treatment system.

1.5 Quality Objectives and Criteria

The overarching goal of the work under this 2013 Supplement to the FSP is to fill data gaps described in summary terms in Section 1.3 above, and in more specific detail in Section 2.0 below. These data and data acquired during prior (pre-UAO [EPA, 2011b]) investigations (Figure 3A), the original 2011 FSP work (Figure 3B), and the first Supplement to the FSP work in 2012 (Figure 3C) are and will continue to be used to support siting, technical analyses, and ultimately final design of the civil engineering and geotechnical aspects of the remedial actions to be proposed by AR and adopted by EPA for the Site.

Specific data quality objectives (DQOs) and associated criteria for the planned 2013 investigations are summarized in Table 1. The first column in the table describes the identified quality objectives, i.e., what information is to be acquired and the data gap that is to be filled. A brief description of the investigation(s) to be performed to meet each objective is provided in the second column. Qualitative criteria are presented in the third column, identifying the aspects of the objective that are most important to meet in order to fill the data gap. The criteria are qualitative rather than quantitative, given that in most instances specific quantitative measures are not applicable or they depend on the field conditions encountered. Minimum quantitative criteria are provided where appropriate in Section 2.0, where each of the planned investigations is described in some detail. For example, the planned number and location of borings are shown on a map (Figure 4) and summarized in a table (Table 2), and the minimum sampling/testing interval of standard penetration tests (SPTs) with depth is provided. Note that action limits, laboratory detection limits, and precision, bias, and method sensitivity are not judged applicable to the field and laboratory data to be acquired during these investigations and are not further addressed in this 2013 Supplement to the FSP.

Detailed consideration has been given to prior data acquired at the Site as a significant part of the basis for developing the DQOs for this 2013 Supplement to the FSP. This consideration included assessment of the anticipated range of conditions that may be expected at each field exploration location and for each type of geotechnical testing planned.

All data collected under this 2013 Supplement to the FSP will be compared to nearby similar data previously collected, as a check on the reasonableness of the new data. It is important to recognize, however, that such a comparison must be made with appropriate professional judgment, given that geologic and geotechnical conditions can and do sometimes vary significantly over short distances, and conditions can change at any given location over time.

1.6 Special Training Requirements and Certifications

AECOM and AECI field and laboratory technicians and professionals performing work under this 2013 Supplement to the FSP will have the appropriate educational and professional qualifications and experience commensurate with their specific responsibilities. These staff will be approved by the Certifying/Design Engineer and Investigation Field Manager based on their knowledge of the assigned staff under their respective control. No other special training requirements or certifications are anticipated to be necessary at this time.

If special training and/or certifications become necessary during the course of the work due to changes in the field or laboratory tasks resulting from unknown Site conditions or changes in project evaluation or design requirements, the assigned staff will be re-qualified as having the required training and/or certifications or replaced by the Certifying/Design Engineer or Investigation Field Manager.

1.7 Documentation and Records

1.7.1 Report Format and Data Report Package

The results of the investigations to be performed under this 2013 Supplement to the FSP will be compiled and presented in a report to be titled the 2013 Geotechnical Investigations Data

Report. The report will reference and summarize the objectives of the 2013 Supplement to the FSP; describe the scope, methods, and results of the 2013 investigations; describe and present the results of data validation; and provide an evaluation of the success in meeting DQOs. The data acquired during the field and laboratory investigations will be summarized in appropriate figures and tables, and the raw data provided in appendices.

A proposed Table of Contents for the 2013 Geotechnical Investigations Data Report is included herein as Table 3. Note that additional and/or revised subsections may be incorporated into the report depending on the results of the investigations. Also, note that the results of the investigations performed pursuant to the 2013 Supplement to the Investigation Plan for Collapsed Adit Area at St. Louis Tunnel (Atlantic Richfield Company, 2013a) will be included in this same report.

1.7.2 Other Project Documents

No other formal project documents are planned. Technical project files will be maintained by AECOM and AECI in accordance with the companies' standard practices.

1.7.3 Project Document Storage and Retention

Project documents are stored in a filing system structured in accordance with the ISO 9001:2008 standard on AECOM's secure Denver server, which is regularly and automatically backed up by AECOM's IT Department. The current back-up procedure is as follows:

- Full backups are performed on each server nightly, Monday through Sunday.
- Daily file servers and exchange database tapes are on a 4-week rotation. SQL and Oracle databases are on an 8-week rotation. For hourly backups, new data is appended to the hourly tape every hour.
- The tape is formatted when the Monday case for the same color comes back from the rotation. These tapes are kept in-house.
- Tapes from nightly backups will be sent off-site each day to a secure records storage and management facility. The oldest set of weekly tapes in the rotation that are stored off-site will be returned to the office and put back in rotation, with the exception of the last day of the month.
- Every last day of the month, the tape(s) will be permanently archived off-site to a secure records storage and management facility.

Pursuant to Section IX. WORK TO BE PERFORMED, Paragraph 39, Record Retention of the UAO (EPA, 2011b), all non-identical copies of records and documents that relate to the work under this 2013 Supplement to the FSP shall be preserved and retained for a period of 10 years following Notice of Completion of Work issued by EPA. At the conclusion of the document retention period, AR will provide EPA with at least 90 days' notice prior to the destruction of any records or documents previously retained that are related to the work under this 2013 Supplement to the FSP.

1.7.4 QA Project Plan

This 2013 Supplement to the FSP constitutes both the sampling plan and the QA Project Plan (QAPP) for the work described herein. When revisions are made to the 2013 Supplement to the FSP, the designated QA Manager will distribute the revised plan to the individuals identified on the Distribution List located in the Table of Contents. The listed individuals are then responsible for disseminating the revised plan to other members of their respective project teams as appropriate.

2.0 Data Generation and Acquisition

This section describes the basis for selection of specific locations and types of field investigations (i.e., sampling process design), sampling methods, and sample handling and custody.

2.1 Engineering Geologic Mapping

A preliminary engineering geologic map was prepared based on reconnaissance field mapping in 2011 (Atlantic Richfield Company, 2011b) and published geologic maps (see Figure 5). The primary objective of the mapping planned under this task is to update and refine the preliminary geologic mapping to detail the location and extent of exposed calcines and other mining/processing related deposits (e.g., waste rock) in and around the overall St. Louis Ponds system. This mapping will be further updated and refined based on the results of the other field investigations described later herein.

Available aerial photographs of the Site and adjacent ground have been compiled, and photo-interpretation currently in progress will be completed prior to mobilizing back to the field in 2013. The photo-interpretation includes identifying and mapping evidence of surficially exposed and recognizable calcines, lime-addition treatment solids, and waste rock deposits at various points in time for which historic aerial photography is available. The results of the photo-interpretation will be combined with review and compilation of information from prior test pits and soil borings to provide as complete of a base map as possible prior to the field mapping to be carried out in the summer of 2013.

2.2 Geotechnical Field Investigations

2.2.1 Background

Substantial subsurface investigation and reconnaissance geologic mapping have been performed at the St. Louis Ponds site over at least the past 30 years, including a major program of investigations completed in 2011 (Part A of Atlantic Richfield Company, 2011b) and in 2012 (Atlantic Richfield Company, 2013b – submittal pending). Figures 3A, 3B, and 3C show the locations of previous subsurface investigations at the St. Louis Ponds site through 2012. This previous subsurface investigation and reconnaissance mapping (Figure 5) information was used, together with conceptual layouts and planning of potential future facilities, to develop the supplemental subsurface investigation and laboratory testing programs described in this 2013 Supplement to the FSP. This work is scoped to fully address the data gaps identified in Section 1.3 above.

2.2.2 Sampling Process Design

Figure 4 shows the location of geotechnical borings and monitoring wells to be completed in 2013 under this plan, together with all previous exploration at the site. Note that test pit locations will be determined in the field by AECOM's geotechnical engineer or engineering geologist. The locations identified on Figure 4 have been reviewed for access by AECI based on site knowledge and experience gained from the extensive prior field investigations performed in 2011 and 2012. If, however, these locations cannot be accessed due to unanticipated changes in Site conditions or inclement weather, then potential alternate locations will be identified by the field engineering geologist or geotechnical engineer as suitable to meet the DQO for the original location to the extent feasible. The proposed locations will then be reviewed by the Investigation Field Manager and the Certifying/Design Engineer and a consensus decision made as to relocating or abandoning the location. Relocation will be properly documented. If an especially significant location requires relocation, the EPA will be notified to seek concurrence on the proposed new location. However, none of the proposed locations in this 2013 Supplement to the FSP are judged so critical that minor relocation would be inappropriate. If weather is the cause of the inaccessibility, the sequence of the field explorations will be adjusted to the extent feasible to delay accessing the site at issue until weather conditions improve.

The investigations at each primary site or facility, and where additional groundwater data is judged necessary, are described in Sections 2.2.2.1 through 2.2.2.4, and in Section 2.2.2.5, respectively. This work is summarized on the Field Investigations Summary included as Table 2. Drilling and sampling, downhole geophysical logging, test pitting and sampling, and sample handling methods are described in Sections 2.2.3, 2.2.4, 2.2.5 and 2.2.6. The latest edition of the Engineering Geology Field Manual (U.S. Bureau of Reclamation, 1998/2001) will be used as a general guide for performing the subsurface investigations, including construction and development of piezometers / monitoring wells.

2.2.2.1 Pond 19 Area

The objectives of the investigation of the former Pond 19 area (as shown on Figure 4) are to assess subgrade conditions in an area that may be excavated to enlarge or replace in whole or in part the existing Pond 18, and to provide information on the presence, character and thickness of any calcines encountered in support of the CSM. This area is believed to have received calcines from the historic acid plant processing based on review of available aerial photography and the visible presence of calcines and mixed mine waste deposits at the surface. To accomplish these objectives, two sonic-drilled borings (P19-101 and P19-102) will be drilled, one to 75 feet and the other to 35 feet, in the former Pond 19 area immediately north of the existing Pond 18. This drilling will be coordinated with construction of the demonstration wetland also planned for this general area. A nominal 5-foot SPT sampling interval is planned. If possible, up to four Shelby tube samples of the calcines will be recovered for potential geotechnical laboratory testing (and possibly analytical chemistry under the forthcoming CSM Work Plan).

These borings will be completed as geotechnical groundwater monitoring wells, one screened in the coarse alluvium just beneath the calcines, and the other in the underlying sandy alluvium, with the screened intervals chosen based on the logging and sampling results.

2.2.2.2 Pond 13 Area

The objectives of this investigation are to further define the extent and depth of solids and calcines, and to evaluate foundation support characteristics relative to use of the Pond 13 area for possible permanent disposal of solids removed from Ponds 15, 14, 12, and 11; possible permanent disposal of Pond 18 solids currently in the interim drying facility (IDF); and other solids from future lime treatment (if adopted as a long-term treatment process).

This work will include one additional boring not completed in 2012 (P13-104, to a reduced depth of 35 feet). This boring will be completed by sonic drilling methods from the east bank of Pond 13, with a typical 2.5-foot sampling interval through the surface fill, solids, and calcines, and a 5-foot interval thereafter. An additional monitoring well MW-105 will be installed on the Pond 13 causeway as discussed in Section 2.2.2.5 Geotechnical Piezometers / Monitoring Wells. Shelby tube samples will be attempted in the surface solids and calcines, and split spoon samples are planned in the embankment fills and alluvium. At completion, the boring will be grouted closed.

In order to cover the possibility that the existing solids and calcines are left in place as the foundation material for a permanent repository, additional Shelby tube samples of the solids and calcines will be collected for laboratory testing. In a manner similar to the periodic sampling done in the IDF, a trackhoe working from the pond perimeter and causeway will be used to collect tube samples of these materials.

Before adding new solids during 2013 from Ponds 11 and 12 that could potentially cover the causeway, the riser pipes for monitoring wells P13-102 and P13-103 will be raised. A submersible water level transducer and cabling will be installed in P13-102, P13-103, and MW-105 to retain groundwater depth measurement capability as necessary.

2.2.2.3 Calcines, Solids, and Waste Rock

The objective of this investigation is to evaluate the approximate depth and lateral extent of calcines in selected locations other than those known to exist in the former Ponds 16/17 area. Based on preliminary aerial photograph review, the other candidate areas include: the former Pond 19 area; a possible old pond north of Pond 19 (since filled over); and existing or former Ponds 18, 15, 13, 11, 10, 8, 7, 6, and 5 through 2 (east part) areas.

Surficial Mapping. For the overall St. Louis Ponds system, surface evidence of calcines will be documented as part of the engineering geologic mapping and reference to historical aerial photographs, prior borings, and test pits, per Sections 2.1 and 2.2.1.

Drilling and Sampling. Calcines in the former Pond 19 area will be investigated via the two borings noted in Section 2.2.2.1, and those in former Pond 13 will be evaluated via the methods discussed in Section 2.2.2.2.

CHIRP Sonar. Lime-addition treatment solids and calcines in wet Ponds 15, 10, and possibly 11, 8, 7, 6, and 5 will be evaluated indirectly using a geophysical technique called Compressed High Intensity Radar Pulse (CHIRP) Sonar. The method may also be attempted in Ponds 18, 14, 12, and 9 to evaluate treatment solids thickness (and calcines if present), as noted below.

The sub-bottom profiling will be performed in accessible ponds in an attempt to indirectly (non-intrusively) measure the depth, assumed sub-horizontal surface (boundary) configuration, and thickness of unconsolidated "sediment" (i.e., treatment solids, calcines, and/or natural earthen sediment) in a given pond, and to locate the interface with the underlying predominantly coarse sand/gravel alluvium. If the technique is successful in being able to distinguish among the various known and potential unconsolidated materials in the pond bottoms, then volumes of each material type can also be estimated for each accessible pond.

The equipment consists of a shallow water CHIRP sonar sonde that can operate within a minimum pond water depth of 1.7 feet, with the pond depth adjusted as needed by inflow/outflow management of the available freeboard. The sonar has a vertical resolution of 4 to 8 cm, and can penetrate up to 2 meters in coarse sand and as many as 40 meters in clay sediments. The system collects the data while navigating survey transect lines. The sonar sonde will either be attached to the sonar company's boat or from a temporary movable cable system deployed over the pond surface. The data is collected in geo-referenced measurements of water depth and sub-bottom sediment depth using a survey-grade, sub-bottom profiling echo sounder (approximately 20 soundings per second). It is anticipated that the sensitivity of this technique may be able to distinguish boundaries between the very high water content, soft silt-sized solids, moderately dense, water-deposited silty-sand-size calcines, and the underlying dense, typically sandy/gravelly, natural alluvium.

Hydrographic software, in combination with AutoCAD, is used to compile the data into drawings of water depth contours and sub-bottom material type (sediment, solids, calcines) contours, and to calculate volumes. Cross-sectional views of the water depths and sub-bottom sediment depths are generated showing thicknesses of the accumulated sediments in a color-coded, geo-referenced sediment thickness profile.

In ponds where the available water depth is not sufficient to operate the CHIRP sonar system, then manual probing will be performed where it can be done safely from a shallow-draft water craft. Probing will be performed per the recommendations of the U.S. Army Corps of Engineers.

Information from a potential subcontractor describing the CHIRP Sonar system is attached.

2.2.2.4 Test Pitting and Sampling

Up to four test pits will be excavated, logged, and sampled in the SSR-A area at and immediately east of former Ponds 16 and 17 to further assess subgrade conditions and potential borrow materials, and to acquire samples for laboratory testing. It is possible that a limited number of test pits may also be required to supplement the information collected from the engineering geologic mapping and drilling programs described above. The primary objective of the test pits would be to observe and sample the full range of gradation, structure and consistency (density) of existing fill, treatment solids, and calcines where feasible. To accomplish this objective, up to an additional six test pits may be excavated. Proposed locations for test pits are not shown on the attached field investigations map (Figure 4), as the locations will be selected by AECOM's geotechnical engineer or engineering geologist with input from AECI based on the engineering geologic mapping and soil boring results. Potential target areas for test pits in addition to the SSR-A site include the calcines in the former Pond 19 area, the former pond (tentatively to be known as Pond 20) north of the Pond 19 area, and the solids and calcines in the former Pond 13 area.

2.2.2.5 Geotechnical Piezometers / Monitoring Wells

The primary objective of this investigation is to evaluate groundwater and seepage conditions relevant to geotechnical performance within the former Pond 19 area (P19-101 and P19-102); north of the former Pond 19 area (DG-3), which will replace former well GW-2 that was damaged several years ago); DG-1S/1D and DG-2S/2D side-by-side or dual completion monitoring wells at the far south end of the site near Ponds 1 and 5; and the former Pond 13 area (MW-105). This investigation will also provide additional information on the geotechnical conditions at these locations, since the borings will be sampled prior to well installation. Note that the primary objective(s) of the DG-series monitoring wells will be discussed in more detail in the forthcoming CSM Work Plan.

To accomplish these objectives, new geotechnical piezometers / groundwater monitoring wells will be installed (two as side-by-side or dual completions) for a total of at least eight new wells. Other locations for groundwater monitoring wells may be identified in the forthcoming CSM Work Plan.

The wells will be screened commensurate with the data required (typical maximum depth is estimated at 75 feet). The piezometers / monitoring wells will be completed with typically 10-foot-long (minimum 5-foot-long), 2-inch nominal diameter PVC factory-slotted well screens at intervals to be determined in the field if groundwater is encountered.

Downhole imaging and geophysical logging will be performed for all eight of the new and between four and 18 selected existing vertical boreholes and monitoring wells in accordance with the procedures described in Section 2.2.4 below. Imaging and logging tools planned include borehole video (for casing assessment), and natural gamma, conductivity (EM39), and thermal neutron (for lithology and saturation). Pending conditions encountered the water quality probe and colloidal borescope may also be used to sample and measure field parameters for groundwater and attempt to measure flow past the screened section.

Measurement of water levels and any sampling for water quality analysis in the existing boreholes or new piezometers/monitoring wells constructed as part of this 2013 Supplement to the FSP shall be performed in accordance with the requirements of the updated Site Quality Assurance Project Plan for Surface Water and Groundwater (Atlantic Richfield Company, 2013c) and Sampling and Analysis Plan for Surface Water and Groundwater (Atlantic Richfield Company, 2013d).

2.2.2.6 Surface Geophysical Surveys

Surface geophysical surveying is planned at the southern end of the St. Louis Ponds site to supplement planned monitoring well installation in 2013 described in Section 2.2.2.5 and refraction microtremor (ReMi) profiling performed during the 2012 field investigations. These surveys will be described in the forthcoming CSM Work Plan.

2.2.3 Drilling and Sampling Methods

It is assumed that the borings in this FSP will be completed at the same time as those at the St. Louis Tunnel adit collapse area, where vertical sonic-drilling (SD) methods will be used. The borings in this 2013 Supplement to the FSP can therefore be completed using SD methods, with or without split-spoon or Shelby tube sampling of soil strata, using the recovered plastic film-cased soil core to obtain gradation and/or plasticity index test samples. Drilling fluid may also be used with the sonic method in the deeper borings below the water table if needed to counter the tendency of sand heave observed in the 2011 drilling work.

If sonic drilling equipment is otherwise unavailable, or where SPT N-values are judged to be critical, mud-rotary drilled (RD) borings will be completed. Typical sampling criteria for RD borings are described as follows. Beginning at the surface, use a 2.5-foot sampling interval through fill zones (e.g., waste rock, calcines, random fill); then use a 5-foot sampling interval through underlying alluvial, colluvial, and/or landslide materials unless the SPT penetration resistance is N<20 blows per foot (bpf), in which case revert to a 2.5-foot sampling interval. Use a standard 2-inch-OD split-spoon sampler and SPT method per ASTM D1586. Solid flight (SFA) or hollow-stem (HAS) augers may be used to advance the boreholes above the shallow groundwater table, whereupon mud-rotary drilling techniques will be used for the remainder of the respective boring.

AECOM or AECI engineering geologists or geotechnical engineers will keep a detailed log of each of the borings. The logs will include, but are not limited to, information on: drilling methods and equipment used; difficult or problematic drilling conditions (loss of drill fluid for RD drilling, refusal, sidewall caving, etc.); depth of noticeable changes in material type; description of materials encountered (gradation, plasticity, density or consistency, color, moisture condition for soils); bedding, nature of contacts between units (sharp, gradational, etc.); structure or features of interest (roots, organics, fissures, voids, precipitates/salts, staining, etc.); depth interval, type and recovery of samples; SPT blow counts; and depth to groundwater, if encountered. The observed or inferred presence of coarse gravel, cobbles, or boulders encountered in the borings will be noted on the logs to support proper interpretation of SPT blow counts.

Recovered samples will be handled by the field sample technician as described in Section 2.2.6.

If perched water is encountered above alluvial groundwater, a decision will be made in the field as to installing a piezometer in addition to the piezometers / monitoring wells described in Section 2.2.2.5 above to permit monitoring that groundwater level over time. This decision will be based on the location of the boring, the depth to groundwater relative to the facility site being explored, and the presence of existing piezometers or monitoring wells that adequately monitor that higher groundwater condition.

Borings that are not to be completed as monitoring wells or otherwise completed with a piezometer will be abandoned upon completion using a fluid cement/bentonite grout in conformance with applicable state regulations.

2.2.4 Downhole Imaging and Geophysical Logging

Downhole imaging and geophysical logging will be performed for selected accessible existing and new vertical boreholes and monitoring wells in the St. Louis Ponds area as discussed in Section 2.2.2.5. After the drilling is completed, each borehole planned for geophysical logging will be accessed by the downhole geophysical logging specialist using a customized logging vehicle with all of the necessary downhole tools, cables, truck-mounted motorized winch, and computer and monitor.

The downhole logging will be performed by lowering a suite of the selected downhole tools connected by a multi-conductor cable down the borehole or monitoring well using the motorized winch. The data collected during the survey will be transmitted to a computer and graphical display and reviewed by the geophysical-logging specialist in real time. This will allow for the geophysical-logging specialist to verify that the tools are operating as expected and make appropriate adjustments to the surveys as necessary to complete the survey data collection objectives.

Imaging and logging tools planned include borehole video (for casing assessment), and natural gamma, conductivity (EM39), and thermal neutron (for lithology and saturation). Pending conditions encountered, the water quality probe and colloidal borescope may also be used to sample and measure field parameters for groundwater and attempt to measure flow past the screened section. If water quality samples are taken for laboratory analyses they will be acquired and processed in accordance with the current project surface and groundwater SAP (Atlantic Richfield Company, 2013c) and QAPP (Atlantic Richfield Company, 2013d).

2.2.5 Test Pitting and Sampling Methods

Test pits will be excavated using a track-mounted excavator (track-hoe) with at least a 20-foot vertical excavation reach. Materials from selected depth intervals representative of stratigraphic or fill units encountered will be sampled from discrete piles placed to avoid mixing with material from other strata/units as directed by the engineering geologist or geotechnical engineer overseeing the work.

At no time will any personnel enter a test pit for any reason. All work shall be conducted from a safe distance from the edges of the test pit with appropriate risk assessment done for the task.

The engineering geologist or geotechnical engineer will maintain a log of the test pit conditions, including approximate plan dimensions, total depth, depths of strata change, detailed description of materials encountered (including color, approximate gradation, plasticity, etc.), and indication (e.g., mottling or staining) plus depth to groundwater or bank/slope seepage (if encountered). Photographs and videos will be taken to document sidewall stability, groundwater seepage/accumulation, and material variations/stratigraphy.

At completion, each test pit will be backfilled with the material excavated from the pit or other suitable backfill as determined by AECOM or AECI using bucket and track tamping for compaction, if feasible. Recovered bulk samples will be handled by the field sample technician as described in Section 2.2.6.

2.2.6 Sample Handling and Custody

Disturbed samples from SPTs and splits from continuous sonic-cased samples will be placed in labeled zip-lock bags to preserve gradation and moisture content for laboratory testing, and stored in labeled and sealed 5-gallon plastic buckets for transport to the laboratory. Thin-wall tube (i.e., Shelby tube) samples of cohesive soils or calcines will be labeled, capped, and taped in the field. If the tube samples will be held for more than 24 hours prior to testing or storage in a controlled-humidity room, the caps will be sealed in microcrystalline wax. Bulk samples from test pits will be stored in labeled, sealed five-gallon buckets. The remaining plastic-wrapped soil core from the sonic-drilled borings will be marked with boring number and top direction, and stored until the end of the 2013 investigations in the on-site metal building or another suitable location safe from vandalism.

A dedicated, full-time field sample technician will be utilized during the majority of the subsurface investigations. The sample technician's duties will include the following:

- Gathering the soil and rock samples from the logger at the back of the drill rigs
- Ensuring that samples are properly identified with a field sample ID number on suitable tags and/or labels filled out with indelible/waterproof ink
- Organizing and bulk packing the samples
- Filling out laboratory chain-of-custody forms as shown on Table 4 (with copies transmitted to AECOM and AECI)
- Seeing that the samples are picked up or sent a minimum of once per week for delivery to the testing laboratories, unless authorized otherwise by the Investigation Field Manager or the Certifying/Design Engineer or their designees

The laboratory tests will be chosen by the AECOM geotechnical engineer as designated by the Certifying/Design Engineer after review of the field boring logs, and transmitted separately to the laboratories.

3.0 Geotechnical Laboratory Testing Program

3.1 Sampling Process Design

The following typical geotechnical laboratory testing program is planned, with variations to be determined by the Certifying/Design Engineer or his designee based on number, length, and type of samples recovered:

- **Moisture Content** – All recovered samples except clean gravels and rockfill (GP, GW); used for soil classification. ***Test Method:*** ASTM D2216 – Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

- **Atterberg Limits** – Representative clayey silt, clay, oxy-hydroxide solids or fine-grained calcine samples (up to 12); used for soil classification. ***Test Method:*** ASTM D4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

- **Hand Penetrometer or Torvane** – All tube samples of cohesive soils (native clays or clayey silts, and oxy-hydroxide solids or fine-grained calcines); used for soil classification and to estimate unconfined compressive strength. ***Test Method:*** Per equipment manufacturer's instructions.

- **Unconfined Compression / Dry Unit Weight** – Representative cohesive samples (up to 10); used to estimate unconfined compressive strength, undrained shear strength, and unit weight for slope stability and foundation/subgrade analyses. ***Test Method:*** ASTM D2166 – Standard Test Method for Unconfined Compressive Strength of Cohesive Soils.

- **Grain Size Analysis** – Representative coarse-grained (i.e., predominantly sand and gravel) samples, including miscellaneous fill/mine waste/demolition debris, sidehill colluvium, and landslide debris, calcines, and borrow sources (up to 20); with determination of percent passing USCS No. 200 sieve; the results will be used for evaluation of foundation/subgrade stability, seepage analyses through the flood dike, embankment and pond bottoms, and evaluation of borrow sources to provide structural embankment fill and possibly filter and/or drain material. ***Test Method:*** ASTM D422 – Standard Test Method for Particle-Size Analysis of Soils.

- **Direct Shear** – Representative re-compacted sidehill colluvium, dike fill, and calcines samples (up to six samples of the minus 1-inch fraction). Density of re-compacted samples is to be based on field nuclear density and/or SPT results. The results are to be used for foundation bearing capacity and slope stability analyses. ***Test Method:*** ASTM D3080/D3080M – Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions.

- **Triaxial Shear** – Representative compacted samples of the minus 1-inch fraction of colluvium, landslide debris (not failure plane material), dike fill, or calcines samples (up to four). The results are to be used for foundation bearing capacity and slope stability analyses. ***Test Method:*** ASTM D4767 – Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils.

- **Moisture/Density (Proctor) Testing** – Representative on-site colluvium, calcines, fill, waste rock, and possibly selected off-site borrow sources (up to four). These test results are to be used to establish density and moisture content criteria for engineered fill placement. ***Test Method:*** ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 [600 kN-m/m^3]).

Receipt of the Chain of Custody Record (Table 4) will be acknowledged by the laboratory upon checking that all samples on the form were in fact received in good condition. If there are any discrepancies between the Chain of Custody Record and the samples received, the laboratory QC Officer shall immediately notify the Investigation Field Manager and the Certifying/Design Engineer so that resolution can be planned and implemented.

Laboratory tests will be completed per associated ASTM Standards as noted in this Section 3.1, or other industry-recognized standards as agreed to by the Certifying/Design Engineer and approved by the EPA. Any variations in procedures per the standards that are judged warranted to accommodate sample size or condition, if any, shall be approved by the Certifying/Design Engineer and the EPA prior to implementation of the affected testing. If a test is run improperly, the laboratory QC Officer shall immediately notify the Certifying/Design Engineer so that resolution can be planned and implemented. If sufficient sample remains and the sample material quality or condition has not been compromised, the test will be re-run on the remaining material. If this is not feasible, additional sample will be acquired from the field under the direction of the Investigation Field Manager and shipped to the laboratory.

Testing turnaround time will be coordinated on a case-by-case basis between the Certifying/Design Engineer and the laboratory to achieve milestone dates in the currently approved EPA Work Plan Schedule dated January 10, 2012. Unless specifically authorized otherwise by the Certifying/Design Engineer, testing on all samples shall be completed no later than six months following receipt of the sample at the laboratory.

Specific method performance criteria are incorporated in the test method standards cited above.

Non-direct measurements are not planned during the laboratory testing program described herein.

Samples not tested will be retained at the geotechnical laboratory or at a secure off-site storage facility for a minimum of six months following receipt of the samples at the laboratory. The laboratory will be instructed to issue a notice to the Certifying/Design Engineer no less than 15 days prior to disposal of any samples after the expiration of the above retention period. If necessary for the purposes of the work under the UAO (EPA, 2011b), the Certifying/Design

Engineer will direct the laboratory to extend the retention period or recover the samples for storage at an alternative secure location.

3.2 Quality Control

The Certifying/Design Engineer and Investigation Field Manager will approve the selected geotechnical laboratories prior to employing the laboratories and before commencing any testing activities. The role of the testing laboratory is to provide testing of soil (and possibly rock core) samples recovered from the borings and test pits completed as part of this 2013 Supplement to the FSP.

The selected laboratories will be required to submit a laboratory quality assurance/quality control (QA/QC) plan to AECI and AECOM for review and approval prior to performing any work on the project. Any deficiencies identified will be corrected prior to commencing any testing. The Laboratory QA/QC Plan shall, at a minimum, address the following topics to the satisfaction of AECI and AECOM:

- **Sample Handling, Storage, and Custody** – Sample storage location; temperature and humidity controls; security; and documentation of receipt, transfer, and disposal

- **Instrument and Equipment Testing, Inspection, and Maintenance** – Equipment maintenance schedule; testing criteria; availability and location of spare parts; inspection of equipment before usage; individuals responsible for testing, inspection and maintenance; and how deficiencies will be resolved, re-inspections performed, and effectiveness of corrective action determined and documented

- **Instrument and Equipment Calibration and Frequency** – Identification of equipment, tools and instruments that need to be calibrated and frequency of calibration; how calibrations will be performed and documented, indicating test criteria and standards or certified equipment; and how deficiencies will be resolved and documented

- **Inspection and Acceptance for Supplies and Consumables** – If applicable, identification of critical supplies and consumables, noting supply source, acceptance criteria, and procedures for tracking, storing, and retrieving these materials

Quality control measures typically associated with chemical analytical testing are not applicable to the geotechnical testing to be performed under this 2013 Supplement to the FSP. Checks will be made by the laboratory during the course of their work to ensure that all required tests have been performed or are scheduled to be performed. If any samples are identified as missing, the laboratory QC Officer shall immediately notify the Certifying/Design Engineer and Investigation Field Manager so that resolution can be planned and implemented. If the missing sample is found critical by the Certifying/Design Engineer, then an additional sample will be acquired from the field under the direction of the Investigation Field Manager and shipped to the laboratory for testing.

4.0 Data Management

Project data, documents, and records are managed in accordance with AECOM's Project Document and Records Control Procedure attached to this 2013 Supplement to the FSP.

All field and laboratory data collected under this 2013 Supplement to the FSP will be compiled, scanned to digital format as necessary, and stored on an AECOM server in the Denver, Colorado, office per the practices described in Section 1.7.3. Scanned documents converted to digital data will be in pdf, tif, or jpeg format. Data and documents generated in digital form will be stored in their native format; duplicates of these native digital files will also be converted to pdf, tif, or jpeg format to facilitate data sharing while maintaining data integrity.

Originals of field logs will be collected upon completion of the field investigations and stored in the project filing system at AECOM's Denver, Colorado, office. The information on field boring logs will be entered into gINT logging software by someone other than the person who logged the boring in the field; the field logger will then review and edit the gINT log, and the final gINT log will be reviewed by the Certifying/Design Engineer or his designee.

Data management will be overseen by the AECOM Project Manager with the assistance of the Certifying/Lead Engineer.

5.0 Assessment and Oversight

5.1 Assessments and Response Actions

AECOM utilizes and maintains a quality management system (QMS) that is certified to the international ISO 9001:2008 standard, yet sufficiently flexible to address the specific requirements of each project. Quality management is central to AECOM's project management approach, and our project team includes individuals assigned to specific quality roles under the QMS system.

Although not specifically required by AECOM's QMS program, the practice of reviewing field boring and test pit operations and field logs during the course of the investigation will be implemented for work under the 2013 Supplement to the FSP. This real-time assessment by the Investigation Field Manager and Certifying/Design Engineer (or their designees) provides the opportunity to identify any deficiencies in the field data collection effort in time to make any necessary corrections while subcontractors and staff are still in the field. Similarly, the Certifying/Design Engineer or his designee will maintain contact with and review in-progress results during the course of geotechnical laboratory testing.

Formal checking and review of all data and documentation prepared under this 2013 Supplement to the FSP are critical QMS activities. Quality-checking activities, which are all documented with two-level approvals, include checking:

- Figures and drawings to confirm content, dimensions, and details

- Studies/reports for content, logic, clarity, and soundness of recommendations, as well as grammar, punctuation, and format

- Calculations to verify correctness and completeness of mathematics, methodology, selection of software, application of standards and codes, and general approach

Additionally, all deliverables undergo a final verification check before they are submitted. An independent reviewer – for the purposes of this 2013 Supplement to the FSP, the QA Manager (in AECOM's QMS terminology, the Project Quality Representative [PQR]) – evaluates the deliverable for completeness and consistency, adherence to quality requirements, and resolution of comments. As needed, the QA Manager communicates any findings in need of remediation to the Certifying/Design Engineer, who is then responsible for making sure the appropriate changes are made. Once the QA Manager is satisfied that all requirements have been met, a Deliverable Release form is signed by the QA Manager and transmitted to the Certifying/Design Engineer for review, and then to the AECOM Project Manager, who is ultimately responsible for the final overlook, approval, and submittal.

This final independent evaluation assesses the submittal's state of readiness without diminishing the Certifying/Design Engineer's or AECOM Project Manager's accountability for the quality of the work being released.

5.2 Assessment Responsibilities

AECOM's approach to project quality management designates the following responsibilities among project team members:

- **Planning and Approach** – Shared by AECOM Project Manager, Project Director, Team Leads, and QA Manager

- **Development and Execution** – Shared by AECOM Project Manager, Team Leads, and Staff

- **Checking** – Independent Reviewers

- **Review** – Shared by AECOM Project Manager and Team Leads

- **Verification** – Shared by AECOM Project Manager and QA Manager

5.3 Reports to Management

The QA Manager will prepare a monthly report on the status of QA activities relevant to the project and submit the report to the AECOM Project Manager and Certifying/Design Engineer. The report will document QA activities over the preceding month, identify any deficiencies in the QA implementation, and recommend actions to address deficiencies.

6.0 Data Validation and Usability

6.1 Data Review, Verification, and Validation

All field and laboratory data generated under this 2013 Supplement to the FSP will be reviewed by an appropriately experienced and qualified professional staff member assigned by the AECOM Project Manager or Certifying/Design Engineer. This staff will be independent and will have had no direct involvement in the technical work being reviewed. Data will be compared to previous data collected at the Site and developed in the geotechnical laboratory to identify potential "red flags" or apparent errors or outliers. If such conditions are noted, the Investigation Field Manager and Certifying/Design Engineer will be immediately notified, and they will develop an appropriate response to further investigate the validity of the data in question and correct it if necessary. Corrective action may range from simply correcting math errors to discarding the data in question.

6.2 Verification and Validation Methods

Data generated under this 2013 Supplement to the FSP will be verified and validated by having appropriately qualified and experienced staff review the data and document any questions, concerns, corrections, or recommendations for further assessment that are appropriate. The documentation may involve direct mark-up on boring logs, data sheets, or data summaries, and/or preparation of a QA memorandum describing the issue in greater detail. Calculations will be checked and evidence of the checking will be made on a copy of the calculation sheet or digital file to include a check mark or other clear identifier and the initials of the reviewer performing the check. Evidence of the methods and calculation checks shall be documented on a Calculation Cover Page and Calculation Review Checklist (included in the attachments).

6.3 Reconciliation with User Requirements

Data that are suspect as to their validity will either be deleted from the project files, or flagged with appropriate data validation qualifiers and/or documented in narrative form to identify the nature and scale of the uncertainty in the reliability of the data. Data qualifiers will be implemented if suspect data cannot be confirmed as invalid, and has potential value to data users. The qualifiers will indicate data limitations and the appropriate level of caution for data users. If flagging is used, it will accompany all distribution of that data to known or potential users.

7.0 References

Atlantic Richfield Company (2013a). *2013 Supplement to Investigation Plan for Collapsed Adit Area at St. Louis Tunnel, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. May 31.

Atlantic Richfield Company (2013b). *2012 Investigations, Analyses and Evaluations (Engineering Geologic and Geotechnical Field Investigations and Laboratory Testing). Rico-*

Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado; submitted to US EPA, Region 8, Denver, CO. (Submittal pending)

Atlantic Richfield Company (2013c). *Quality Assurance Project Plan for Surface Water and Groundwater, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. May 23

Atlantic Richfield Company (2013d). *Sampling and Analysis Plan for Surface Water and Groundwater, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. May 23.

Atlantic Richfield Company (2012). *Supplement to Field Sampling Plan for Solids Repository, Permanent Drying Facility, and Flood Dike and Pond Embankment Improvements, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. July 3.

Atlantic Richfield Company (2011a). *Initial Solids Removal Plan, Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01 Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. May 2.

Atlantic Richfield Company (2011b). *2011 Investigations, Analyses and Evaluations (Part A – Engineering Geologic and Geotechnical Field Investigations and Laboratory Testing). Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado*; submitted to US EPA, Region 8, Denver, CO. December 30.

U.S. Department of the Interior, Bureau of Reclamation (1998/2001). *Engineering Geology Field Manual, Second Edition, Volume I (1998, reprinted 2001) and Volume II (2001).* http://www.usbr.gov/pmts/geology/geoman.html

U.S. Environmental Protection Agency (EPA) (2011a). *Removal Action Work Plan, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado.* March 9.

U.S. Environmental Protection Agency (EPA) (2011b). *Unilateral Administrative Order for Removal Action, U.S. EPA Region 8, Docket No. CERCLA-08-2011-0005; Rico-Argentine Site, Dolores County, Colorado.* March 16.

TABLES

Table 1: Data Quality Objectives and Criteria

No.	Data Quality Objective (DQO)	Performance Description	Criteria
1	Characterize extent and depth of subsurface materials in areas and to depths investigated	Perform geologic mapping, drill borings, and conduct geophysical surveys	Spatial appropriateness (location), and adequacy of extent (number of locations, depth of drilling, and geophysical profiling)
2	Collect representative samples of selected subsurface materials for laboratory testing and archiving for future possible testing and visual examination	Acquire samples from borings utilizing appropriate techniques and equipment (e.g., grab samples of cuttings, drive samples – standard penetration tests [SPT] and California barrel, Shelby tube samples; continuous sonic core samples); perform in situ SPTs)	Sample(s) and SPT(s) from each primary stratigraphic unit encountered using appropriate technique/equipment; sampling interval with depth; sample size
3	Measure depth to groundwater; provide ability to monitor water depth and sample groundwater subsequent to field investigation	Construct piezometers / monitoring wells with screened intervals in targeted aquifer zones	Appropriateness of selected screened intervals to allow monitoring of groundwater levels and sampling of groundwater in targeted aquifer zone(s)
4	Map calcines, treatment solids, and waste rock visible at the surface throughout the Ponds system	Engineering geologic mapping of calcines, treatment solids, and waste rock visible at the surface throughout the Site; collect grab samples by shovel, hand auger, or track hoe at representative locations for potential geotechnical and/or analytical chemistry testing hand auger to minimum 5-foot depth or refusal, whichever is shallower, to investigate depth of calcines	Spatial appropriateness (location and thoroughness of mapped areas), and adequacy of extent (number of locations mapped/sampled)
5	Perform sub-bottom geophysical surveys of accessible ponds to interpret presence and depth of precipitation solids and calcines overlying alluvial deposits	Conduct in-pond sub-bottom surveys on grid pattern utilizing CHIRP Sonar to profile velocities and velocity boundaries with depth in ponds with minimum 1.5-2 feet of water; perform hand-probing where access is possible but conditions are not amenable for CHIRP Sonar	Spatial appropriateness (selected ponds based on accessibility and results of calcines and treatment solids mapping), thoroughness of coverage in profiled areas (spacing of traverses in grid pattern), and adequacy of extent (depth to interpret presence and boundaries of solids, calcines and alluvial aquifer deposits)
6	Determine geotechnical properties of selected, representative materials acquired in borings per DQO 1	Perform geotechnical testing in the laboratory including as appropriate, but not limited to: moisture content, gradation, Atterberg limits, consolidation, and shear strength	Representativeness (samples from selected units and depths); testing per recognized industry standards (ASTM, Corps of Engineers, Bureau of Reclamation, etc.)
7	Document findings of field and laboratory investigations	Prepare 2013 Geotechnical Investigation Report describing scope, methods, and results of all field exploration and laboratory testing	Thoroughness and clarity of report

Table 2: 2013 Field Investigations Summary

Investigation #	General Location	Depth (Estimated)	Rig Type	Monitoring Well	Notes
P19-101	Former Pond 19	35 feet	Sonic-Drilled	Yes	Finish as monitoring well, with screened interval chosen based on drilling results
P19-102	Former Pond 19	75 feet	Sonic-Drilled	Yes	Finish as monitoring well, with screened interval chosen based on drilling results
P13-104	Pond 13	35 feet	Sonic-Drilled	No	Temporary access required to east bank of Pond 13
MW-105	Pond 13	35 feet	Sonic-Drilled	Yes	20 feet +/- from end of causeway; target is near center of Pond 13
P13 Solids/Calcines	Pond 13	5-10 feet (solids + calcines thickness)	Track hoe fitted with Shelby Tube Sampler	No	Position and/or depth may be revised based on investigation results
Calcines, Treatment Solids, Waste Rock	St. Louis Ponds Area	Calcines and treatment solids thickness in ponds down to alluvium (depth varies – typical less than 10 feet)	CHIRP Sonar or hand-probing (over water in ponds)	No	Hand-probing where access over water is possible but conditions not amenable to CHIRP Sonar
DG-1 S/D	South side of Pond 5	TBD	Sonic-Drilled	Yes	Finish as dual completion or side-by-side shallow and deep monitoring wells, with screened intervals chosen by AMEC based on drilling results
DG-2 S/D	Near Pond 1	TBD	Sonic-Drilled	Yes	Finish as dual completion or side-by-side shallow and deep monitoring wells, with screened interval chosen by AMEC based on drilling results
DG-3 (replace former GW-2)	North of former Pond 19	TBD	Sonic-Drilled	Yes	Finish as monitoring well, with screened interval chosen by AMEC based on drilling results

Table 3: 2013 Geotechnical Investigations Data Report Proposed Table of Contents

Table 4: Chain of Custody Record

ANDERSON ENGINEERING COMPANY INC.

977 West 2100 South
Salt Lake City, UT 84119
(801) 972-6222
FAX (801) 972-6235

CHAIN OF CUSTODY RECORD

COC# ____
Page ____ of ____

Client: ____
Project: ____
AECI Contact ____

Lab Name: ____
Lab Contact: ____
Lab Address: ____

Matrix Codes
(W) Water
(S) Soil
(L) Liquid

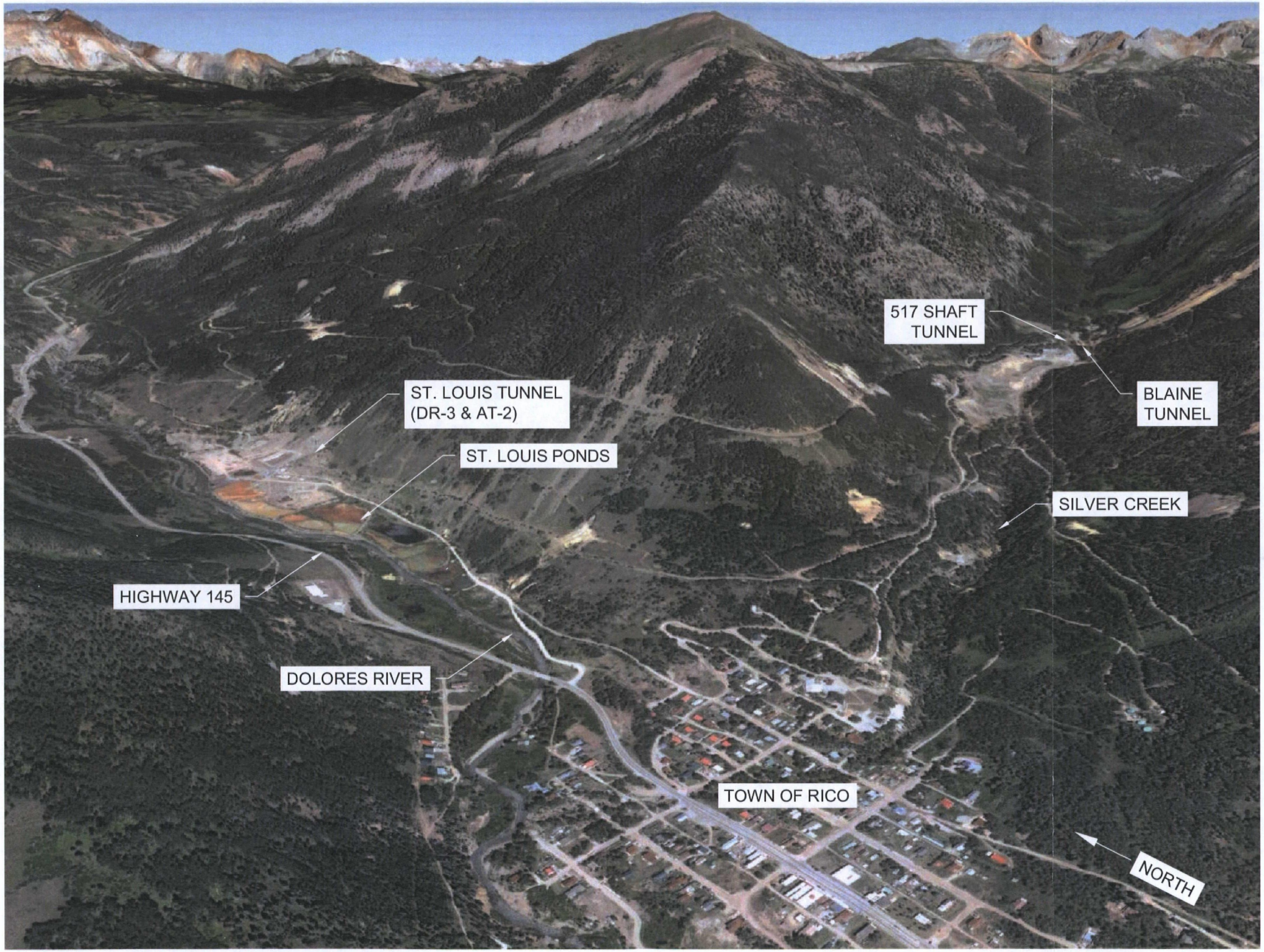
QC: (circle one)
I II III IV

Field Location	Field Sample ID Number	Date	Time	Matrix	No. of Containers	Analysis Requested										COMMENTS

Relinquished By: *signature*	Date	Time	Received By: *signature*		Time	Special Instructions
Relinquished By: *signature*	Date	Time	Received By: *signature*		Time	
Relinquished By: *signature*	Date	Time	Received By: *signature*		Time	
Relinquished By: *signature*	Date	Time	Received By: *signature*		Time	

FLD-002

FIGURES



IMAGERY COURTESY OF GOOGLE EARTH PRO

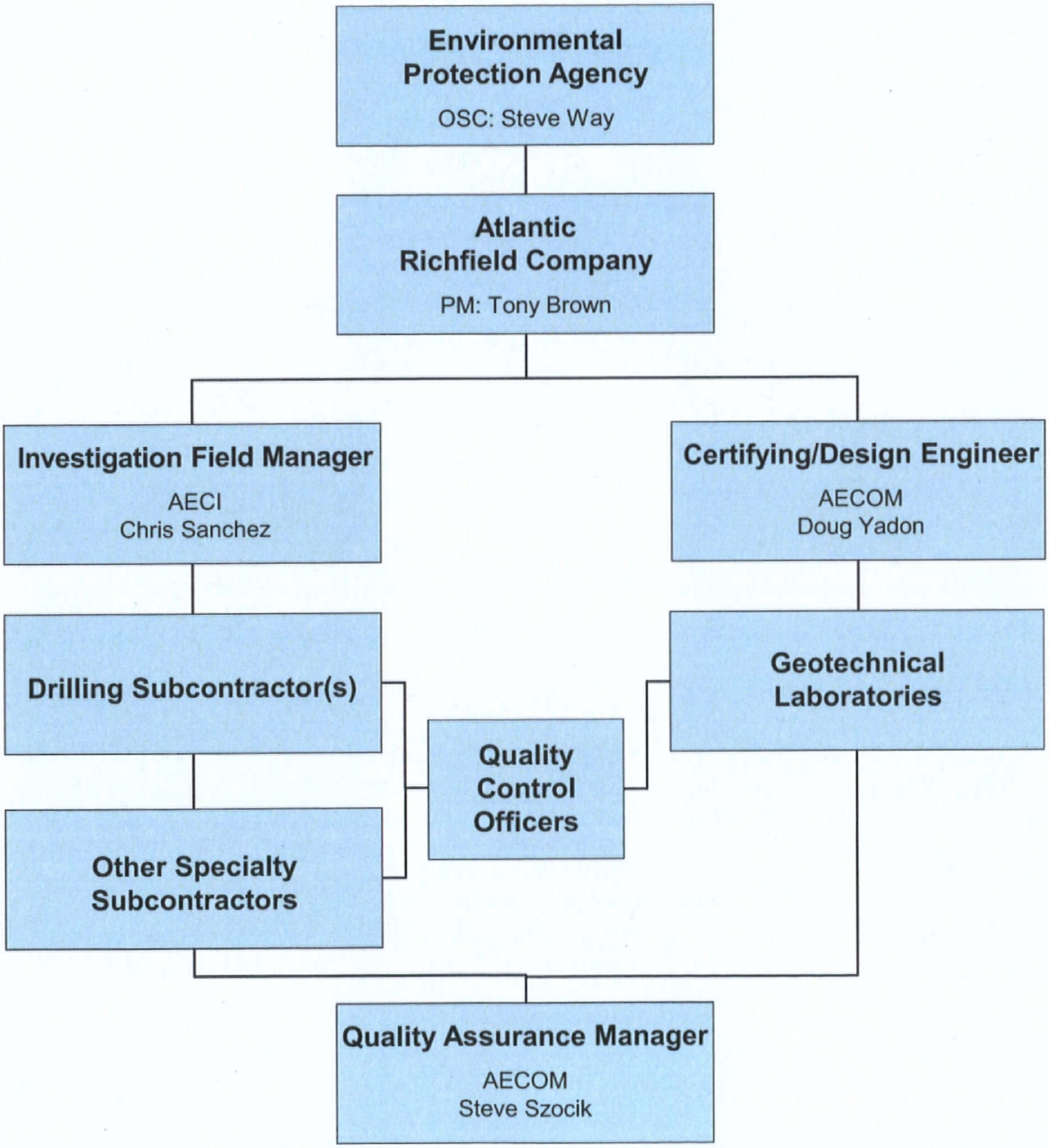
MAY 2013
60239806

RICO-ARGENTINE SITE-OU01

2013 SUPPLEMENT TO THE FIELD SAMPLING PLAN

FIGURE 1 - RICO-ARGENTINE MINE SITE LOCATION MAP

Figure 2: FSP Organization Structure



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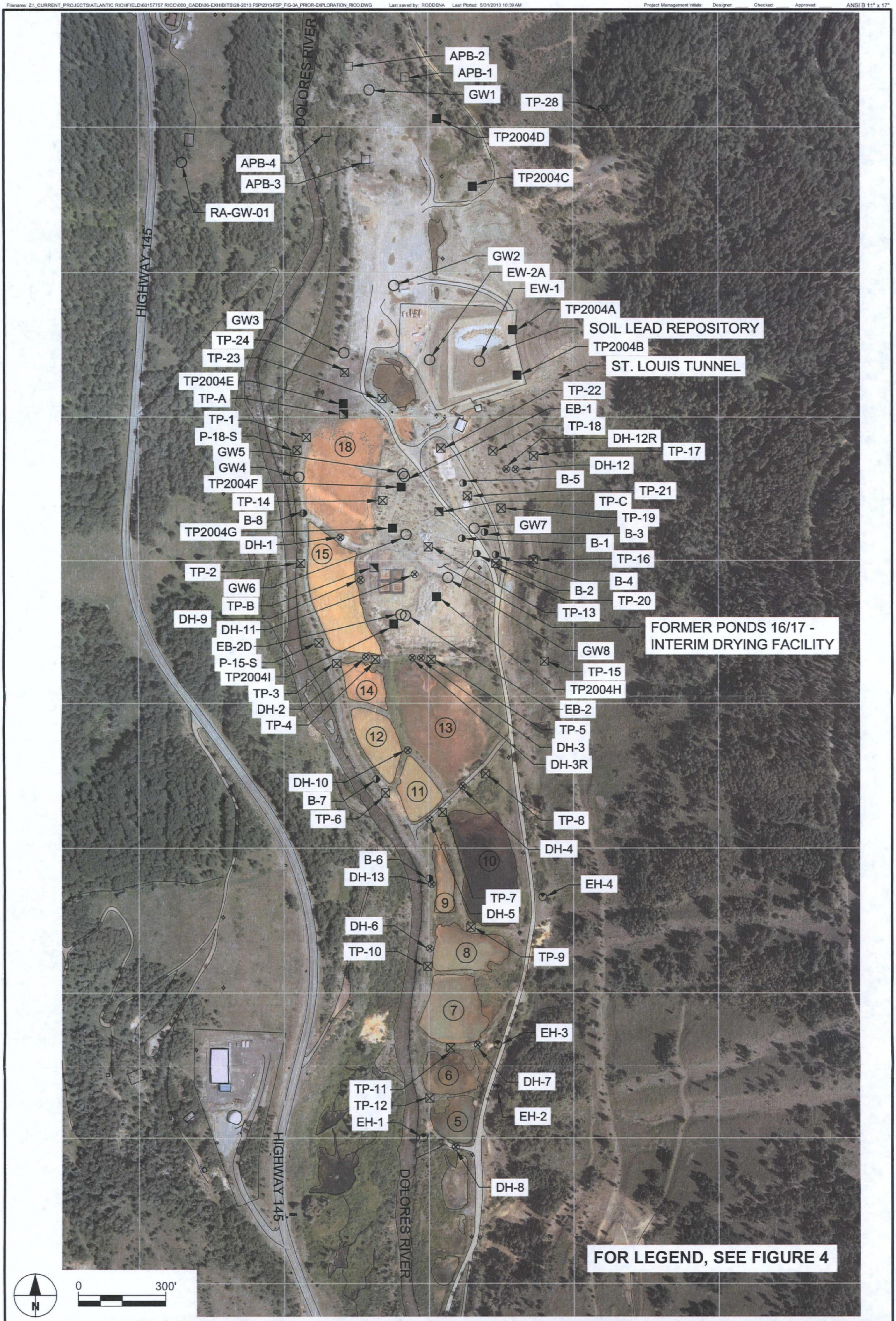

RICO-ARGENTINE SITE-OU01

2013 SUPPLEMENT TO THE FIELD SAMPLING PLAN

FIGURE 3A - SUMMARY OF PRE-2011 FIELD INVESTIGATIONS

AECOM

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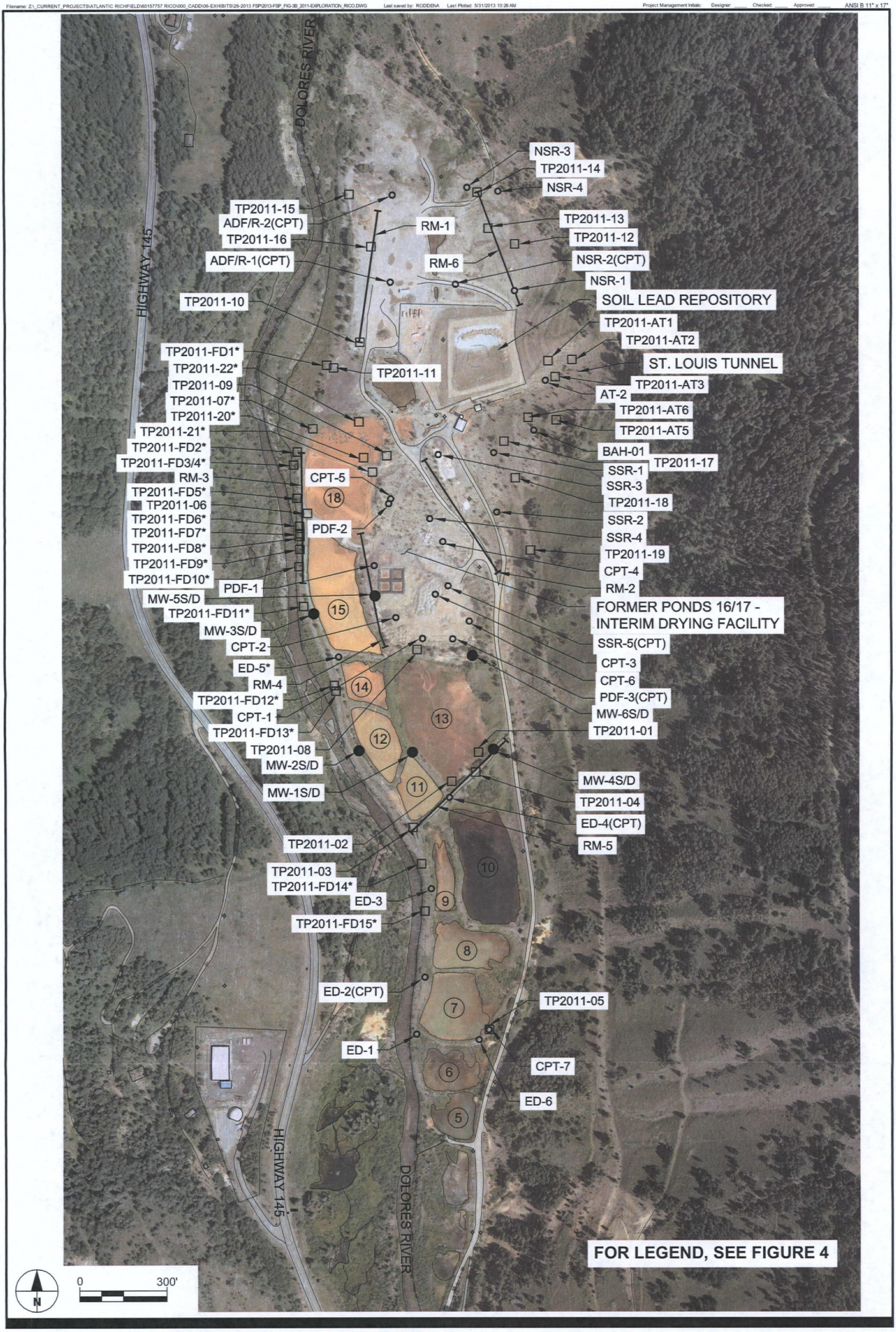
Filename: Z:_CURRENT_PROJECTS\ATLANTIC RICHFIELD\60157757 RICO\000_CADD\06-EXHIBITS\28-2013 FSP\2013-FSP_FIG-3B_2011-EXPLORATION_RICO.DWG Last saved by: RODDENA Last Plotted: 5/31/2013 10:26 AM Project Management Initials: Designer: ____ Checked: ____ Approved: ____ ANSI B 11" x 17"



RICO-ARGENTINE SITE-OU01

2013 SUPPLEMENT TO THE FIELD SAMPLING PLAN

FIGURE 3B - SUMMARY OF 2011 FIELD INVESTIGATIONS

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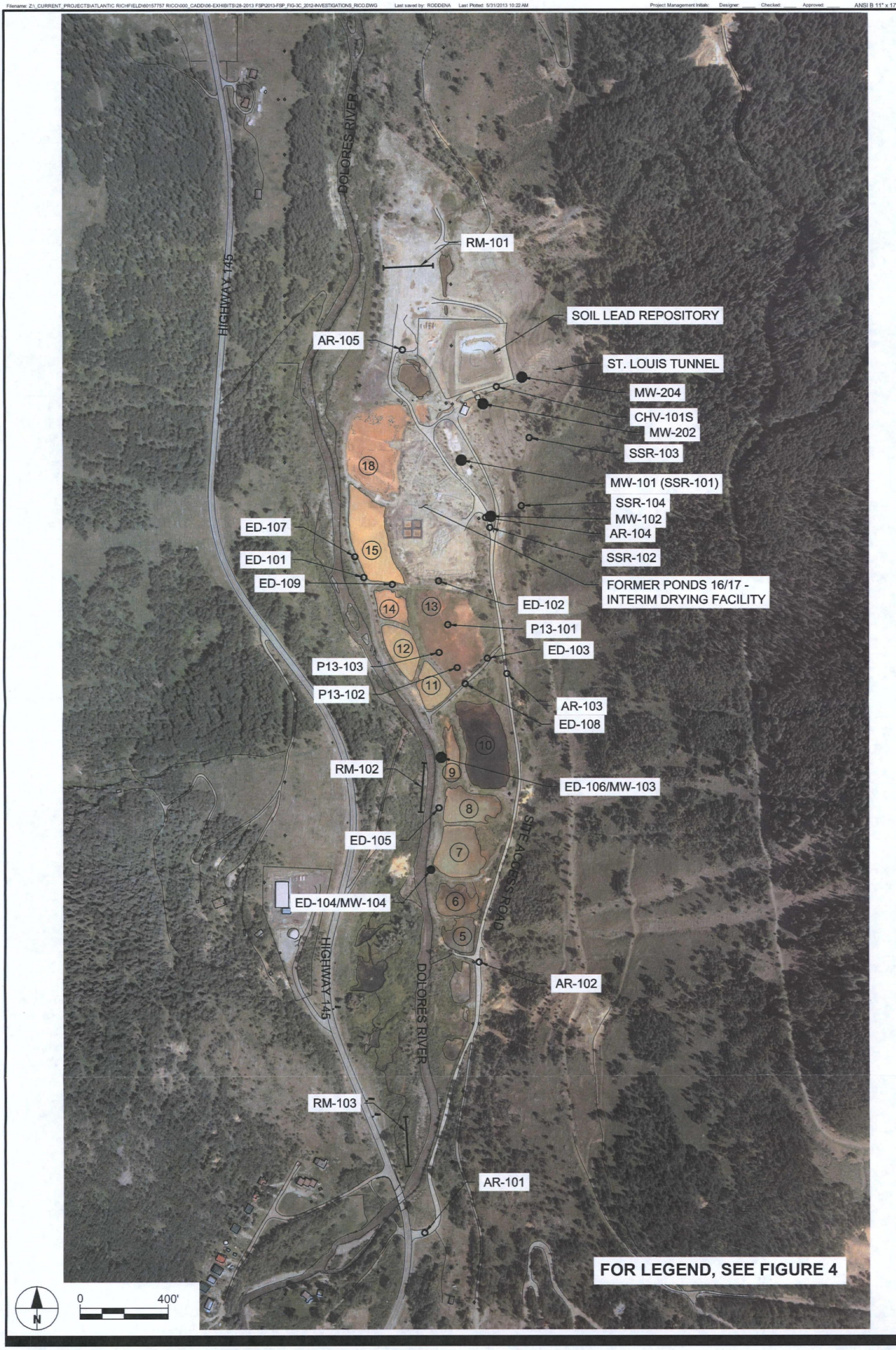
MAY 2013

60239806

Filename: Z:_CURRENT_PROJECTS\ATLANTIC RICHFIELD\60157757 RICO\000_CADD\06-EXHIBITS\28-2013 FSP\2013-FSP_FIG-3C_2012-INVESTIGATIONS_RICO.DWG Last saved by: RODDENA Last Plotted: 5/31/2013 10:22 AM Project Management Initials: Designer: ____ Checked: ____ Approved: ____ ANSI B 11" x 17"



RICO-ARGENTINE SITE-OU01

2013 SUPPLEMENT TO THE FIELD SAMPLING PLAN

FIGURE 3C - SUMMARY OF 2012 FIELD INVESTIGATIONS

AECOM

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60239806

TARGET SHEET

EPA REGION VIII

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOCUMENT NUMBER: 1381432

SITE NAME: RICO - ARGENTINE

DOCUMENT DATE: 05/31/2013

DOCUMENT NOT SCANNED

Due to one of the following reasons:

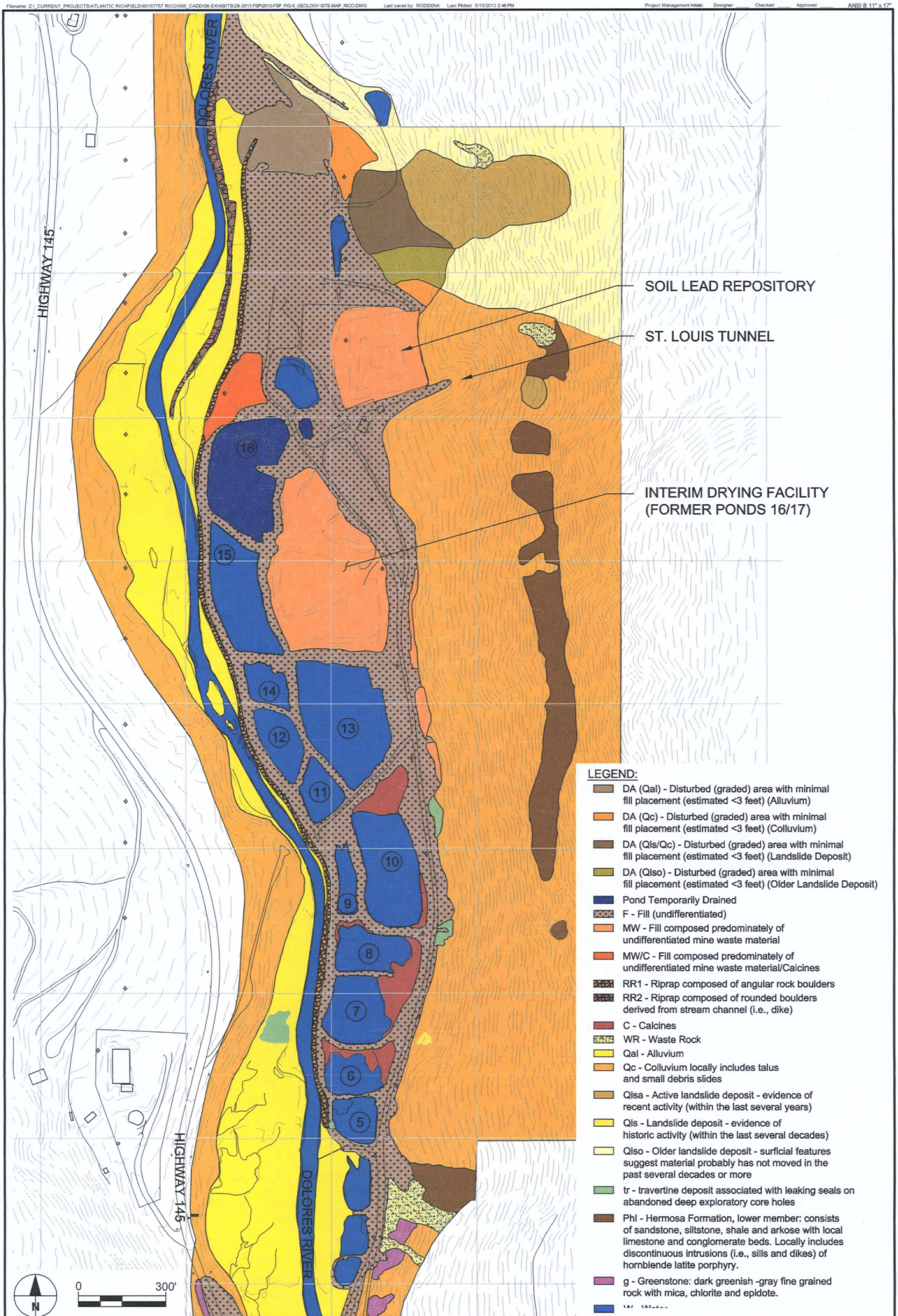
- ☐ PHOTOGRAPHS
- ☐ 3-DIMENSIONAL
- ☑ OVERSIZED
- ☐ AUDIO/VISUAL
- ☐ PERMANENTLY BOUND DOCUMENTS
- ☐ POOR LEGIBILITY
- ☐ OTHER
- ☐ NOT AVAILABLE
- ☐ TYPES OF DOCUMENTS NOT TO BE SCANNED (Data Packages, Data Validation, Sampling Data, CBI, Chain of Custody)

DOCUMENT DESCRIPTION:

FIGURE 4 PROPOSED 2013 FIELD INVESTIGATIONS

Contact the Superfund Records Center to view available document.
(303) 312-6473

Filename: Z:_CURRENT_PROJECTS\ATLANTIC RICHFIELD\60157757 RICO\000_CADD\06-EXHIBITS\28-2013 FSP\2013-FSP_FIG-5_GEOLOGY-SITE-MAP_RICO.DWG Last saved by: RODDENA Last Plotted: 5/15/2013 2:46 PM Project Management Initials: Designer: ____ Checked: ____ Approved: ____ ANSI B 11" x 17"



RICO-ARGENTINE SITE-OU01

2013 SUPPLEMENT TO THE FIELD SAMPLING PLAN

FIGURE 5 - PRELIMINARY ENGINEERING GEOLOGIC MAP

AECOM

MAY 2013

60239806

ATTACHMENTS

Project Document and Records Control Procedure

Project Document and Records Control Procedure Q2-222-PR

1.0 Purpose and Scope

1.1 The purpose of this procedure is to define a standard methodology to enable all project stakeholders to have access to relevant and current project information and to ensure the status of the information is readily identifiable.

1.2 This procedure is to be applied to all documents and records (hard and soft/electronic copy) of internal or external origin that may affect the quality of project work.

1.3 This procedure provides an overview of the requirements for the management, control, storage and retention of information to:

- Provide identification and traceability of project-related information;
- Control document change, revision status and distribution;
- Prevent loss or unintentional use of information;
- Protect the confidentiality, authenticity and integrity of information;
- Provide for efficient storage, retrieval and archiving of project records; and
- Prevent access by unauthorized parties.

The Project Plan procedure shall be used to address the control, maintenance and destruction or final disposition of confidential or sensitive records, all in accordance with local legislation, where applicable. Specific project requirements for the control (maintaining, archiving and disposition) of project records shall be documented in the Project Plan. Control of the corporate level Integrated Management System (IMS) documents and records is addressed under procedure G2-001-PR IMS Document and Records Control.

2.0 Terms and Definitions

2.1 **Controlled Document** – A document that shall be identified, filed and distributed to provide accountability, retrievability and evidence of receipt at locations where they are needed. Examples of controlled documents include the Project Plan, contract with the client, scope change authorizations, subconsultant agreements, background drawings, master specifications, submittal documents, etc.

2.2 **Controlled Records** – Documentation generated or received as evidence of fulfillment of a specific contractual obligation or IMS/PDS (project delivery system) requirement. Records are evidence of results achieved or activities performed. Examples include minutes of meetings, transmittal letters, calculation review checklists, completed project delivery forms etc.

2.3 **Confidential, Sensitive or Classified Project Documents/Records** – Documents/Records that include information or data that is potentially sensitive or confidential. Examples may include security information, commercially sensitive proprietary information, details of public/private infrastructure, fire/life safety data, critical financial data, personal information, government classified documents, claims communication, etc.

2.4 **Correspondence** – Project letters, faxes, emails, data transmissions, memos, records of conversation and minutes/notes of meetings.

2.5 **Imaging Records** – An electronic document imaging system is a computer-based configuration of equipment and software that stores machine-readable document images and their associated character-coded index data for on-demand retrieval. Electronic images can be computer generated or created through document scanning.

2.6 **Project Input** – Incoming information or data received from a client, joint venture partner, subconsultant or other source that contributes to the project work and deliverables.

2.7 **Project Work** – Reports, drawings, specifications, data sheets, models, virtual deliverables, calculations or other output that serves as input to subsequent project stages or shall be delivered to the client.

2.8 **Project File Index** – A list of file numbers or, as may be generated by an electronic system, numbering and naming conventions used to facilitate filing and retrieval of documents and records on the project and across the company

3.0 References

3.1 Project Plan Procedure

3.2 Checking and Verification Procedure

3.3 Project Closeout Procedure

3.4 Geography/Business Line Document Retention Protocol

4.0 Procedure

4.1 Document Control and Logging Requirements – All documents not already listed in the IMS as a project document requiring control shall be defined by the **Project Manager** and described in the Project Plan. Such documents shall be controlled throughout the life of the project.

The use of a document control log is one method that can assist in the control process. If local office practice or project-specific practice dictates, such documents shall be tracked using a log.

4.2 Project Document Control Filing System – The **Project Manager** shall ensure a document control filing system is established at the start of the project to address the filing of all documents and records expected to be developed or received during the life of the project. A Project File Index shall be used as the basis for the project's filing system.

4.3 Work Sharing – The means of controlling documents and records for work shared between Business Lines, Geographies and offices shall be addressed in the Project Plan. The **Managing Office** (i.e., holding the contract) shall be responsible for the filing and control arrangements of project-related documents and records.

4.4 Incoming Documents and Data – The **Project Manager** shall ensure that incoming project documentation is clearly identifiable prior to filing. Project input shall be reviewed in accordance with the Checking and Verification Procedure and annotated as such prior to use/inclusion in project work.

In addition, when electronic project input/media, such as CDs, portable hard drives, etc., are received, a virus check shall be carried out and the media annotated as such prior to use.

Project input received from the client or other third parties and subject to return at project completion shall be clearly identified as client/third party property and shall be verified and stored in a manner that safeguards the integrity of the property until it is returned to the provider. Should this information be lost, damaged or found to be unsuitable, then it shall be reported to the provider at the first opportunity and appropriate records of correspondence maintained.

4.5 Electronic Document Control Filing System – Some projects utilize electronic and/or web-based systems (extranets) in part or in full as their method of filing. In these cases, the overall intent of this procedure shall be met and the filing system shall be set up consistent with the Project File Index. Where both hard and electronic files are kept, the Project File Index shall be the same for both types of files. When a combination of electronic and hard copy files are used on a project, the two systems, when merged, represent the complete project file. Electronically saved documents/records shall:

- Be final "as-issued" versions (not drafts) showing appropriate dates and signatures (typically converted from hard copy by scanning) or
- Contain secure, encrypted and dated electronic signatures; and
- Be stored on a secure, protected and backed-up company server or externally hosted server, such as Aconex, on a temporary basis. Storage of such documents on employee hard drives is not acceptable.

4.6 Electronic Communications – Electronic communications such as emails shall be filed and retained in a project specific file directory. This shall be accessible to designated project team members. If a project-specific electronic directory has not been implemented, all electronic correspondence, including attachments, that potentially impacts any of the following shall be printed and placed into the project file:

- Contract requirements;
- Budget;
- Scope;
- Critical design inputs;
- Client or agency directives;
- Client or agency approvals;
- Comments on deliverables; and/or
- Client complaints.

4.7 Identification and Logging – The project number and file number shall be annotated on all records and documents. Project documents shall be indexed and logged if required by the office-specific document control filing system or if the **Project Manager** elects to utilize logging as a control tool for the project.

4.8 Collection and Filing – Documents required to be maintained and retained shall be collected by the **Project Manager** or delegated for filing as they are created or received. All project documents are to be filed in accordance with the project document control filing system — employees are not permitted to keep private files.

4.9 Duplicative Records – Duplicate file copies may be needed when documents or records meet more than one file folder definition, or when documents are submitted via correspondence. For example, when a subcontractor submits a utility report, it may be filed in the chronological correspondence file as well as a technical file location. If a document control log is not in use for the project (which would clearly identify the location of the document for retrieval), then the **Project Manager** may choose to keep the document in one location and place a note in the other file location identifying where it can be found.

4.10 Oversized Items, Copies of Large Documents, Manuals, Vendor Samples, Etc. – In some cases it is not feasible to maintain items in filing cabinets. In these cases, a note shall be placed in the file in the appropriate filing location identifying the actual location of the item. Standard oversized items, such as drawings, do not require a note to the file as it is understood that these are segregated in flat files, hanging files or stick files.

4.11 IMS/PDS (project delivery system) Forms – Forms shall be signed and dated in the appropriate space on the forms. Signatures shall be provided by one of the following methods:

- In ink and placed in a hard copy file or faxed to another destination;
- In ink and scanned for electronic filing or transmission;
- Using the signer's electronic signature, provided this method is controlled and secured by the signer;
- Using a typed signature provided that the email transmitting the form is included in the project file (hard copy or electronic) with the form; one email will be sufficient evidence for multiple typed signatures provided all signatories are copied on the email; or
- Using a system-generated signature that is secure and cannot be copied.

4.12 Critical Documents and Records – Documents and records the **Project Manager** deems "critical" by nature of their uniqueness, cost to replace, or potential harm to the company if lost or damaged should be protected by appropriate special measures. These measures may include:

- Fire proof cabinets;
- Duplicate storage;
- Off-site storage;
- Additional electronic backup (in a secondary location); and/or
- Lockable storage.

4.13 Confidential, Sensitive or Classified Documents/Records – When documents or records of a confidential or sensitive nature are expected to be created or received during the course of a project, their control, protection, distribution and destruction shall be clearly outlined in the Project Plan. Government classified documents require special handling and will also be addressed in the Project Plan or in supplemental procedures issued by the appropriate AECOM business unit.

4.14 Project Closeout and Archiving – Upon project completion, the **Project Manager** shall ensure that files are prepared for long-term storage in accordance with the Project Closeout Procedure and Geography/Business Line document retention protocol.

4.15 Printing in General – Always consider the environment before printing, use double-sided prints where practicable and recycle redundant/waste paper whenever you can.

5.0 Records

None

6.0 Attachments

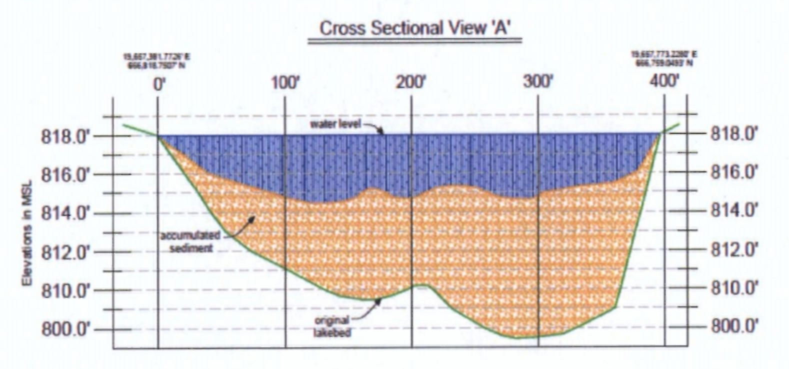
None

CHIRP Sonar Documentation

AFFILIATED RESEARCHERS
offers
Sub-bottom Profiling

Specializing in environmental surveying, AFFILIATED RESEARCHERS utilizes advanced hydrographic remote-sensing instruments and software to provide sub-bottom profiling of lakes, harbors, rivers, canals, estuaries, and marine environments.

Sub-bottom profiling is the preferred method for accurately measuring sediment depth and thickness, as well as sediment volumes that have accumulated on a seafloor, lakebed, riverbed, canal, or harbor.



In addition, sub-bottom profiling is very useful in:

- pre-dredge surveys;
- geological surveys of sediment and substrates;
- locating buried wrecks, debris, and obstructions;
- locating buried pipelines or cables;
- development and calibration of hydrodynamic sediment transport model;
- archeological surveys for buried artifacts; and,
- surveys of bridge, structure, shoreline scouring.

AFFILIATED RESEARCHERS can effectively collect extremely large amounts of accurate, geo-referenced sub-bottom profiling measurements (approximately 20 soundings per second) in a relatively short amount of time; and often exceeding the task criteria prescribed in engineering, environmental, and scientific projects.

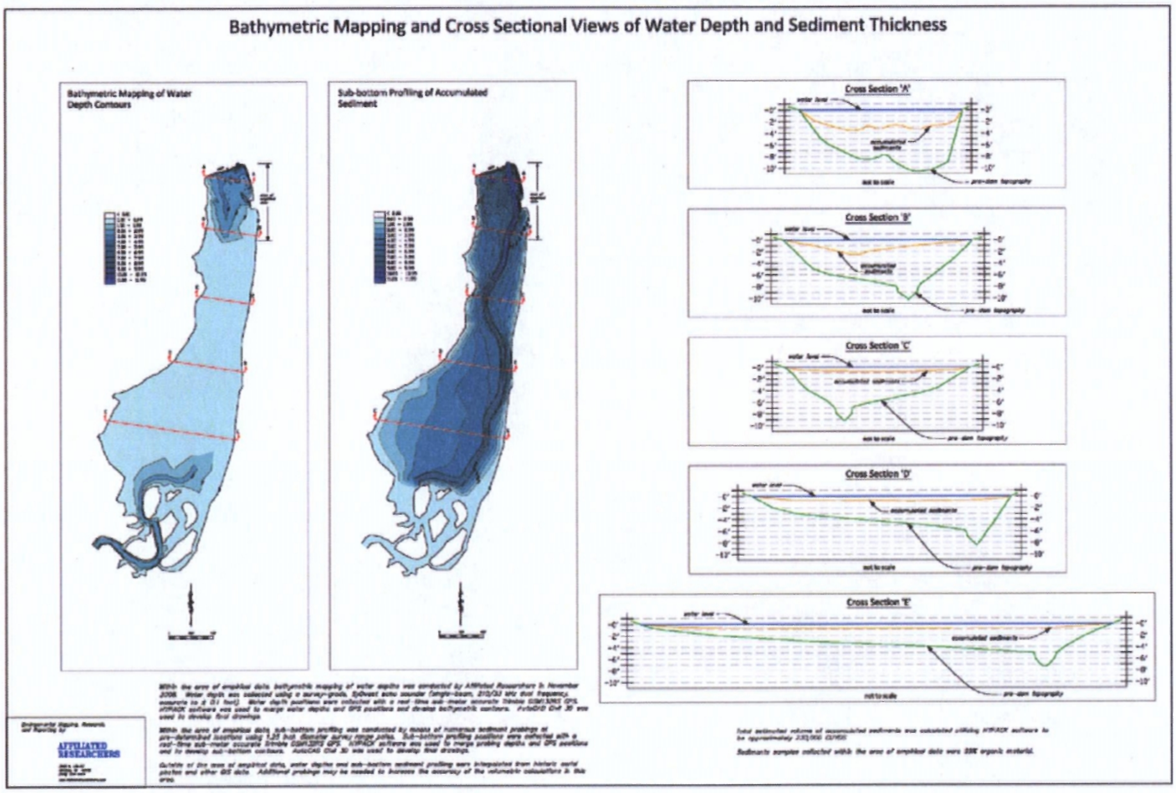
While navigating the survey transects, AFFILIATED RESEARCHERS trained Hydrographers collect geo-referenced measurements of water depth and sediment depth (sub-bottom) using a survey grade, sub-bottom profiling echo sounder.

Hydrographic softwares are used to link a centimeter accurate RTK-GPS to the sub-bottom profiler and import continuous position and elevation data.

(888) 739-5471 • Michigan • California • Virginia • www.affiliatedresearchers.com
Service-disabled Veteran-owned Small Business • Certified HUBZone Business Consideration

AFFILIATED RESEARCHERS
offers
Sub-bottom Profiling

Specializing in environmental surveying, AFFILIATED RESEARCHERS utilizes advanced hydrographic instruments and software to provide sub-bottom profiling of lakes, harbors, rivers, canals, estuaries, and marine environments. Sub-bottom profiling is the preferred method to accurately measure the depth, thickness, and volume of accumulated sediments.



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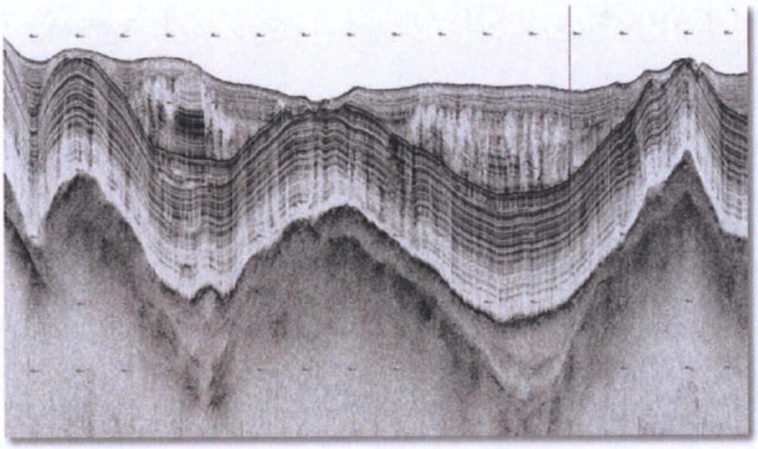
AFFILIATED RESEARCHERS can effectively collect extremely large amounts of accurate, geo-referenced sub-bottom profiling measurements (approximately 20 soundings per second) in a relatively short amount of time; and often exceeding the task criteria prescribed in engineering, environmental, and scientific projects.

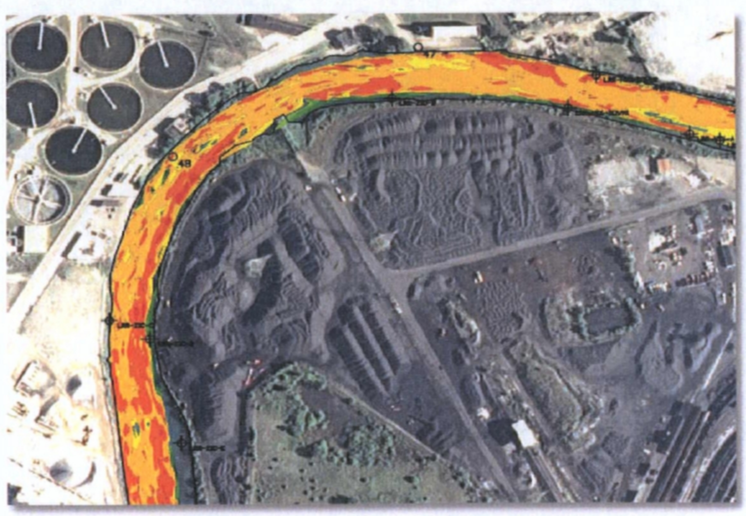
All data (water depth, sediment depth, water elevation, and position) are automatically and continuously recorded in real-time, onto our survey vessels' onboard hydrographic computer.

AFFILIATED RESEARCHERS utilizes an *EdgeTech 3100* shallow-water, sub-bottom profiler to conduct its sub-bottom profiling surveys. The *3100* system utilizes *EdgeTech's* full spectrum CHIRP technology which provides higher resolution imagery and greater penetration of the sub-bottom structure. The *EdgeTech 3100* operates at a frequency range of 4 – 24 kHz; with a vertical resolution of 4 – 8 cm; and can penetrate 2 meters in coarse sand sediments and 40 meters in clay sediments. The *EdgeTech 3100* is ideal for use in rivers, lakes, ponds and ocean applications up to a maximum water depth of 300 meters.



Hydrographic softwares are used to compile the data into hydrographic drawings of water depth contours and sub-bottom sediment contours, and to calculate sediment volumes. Cross-sectional views of the water depths and sub-bottom sediment depths can also be readily generated. An accurate visual representation of the thicknesses of the accumulated sediments is provided from a color-coded, geo-referenced sediment thickness mosaic.

AFFILIATED RESEARCHERS' sub-bottom profiling surveys also include geo-referenced backgrounds of aerial photography, engineering plans, infrastructure surveys, and other databases to show project information. Our deliverables are scaled and established in a client selected real-world coordinate system and elevation datum.



The developed sub-bottom profiling deliverables are readily exported into GeoTIFF, JPEG, PDF, CAD, or GIS formats to enable convenient data sharing. Accurate and detailed 3-D fly-through *Fledermaus* depictions of the deliverables can also be provided to enable better visualization.

AFFILIATED RESEARCHERS provides sub-bottom profiling services nationwide and throughout the US territories.

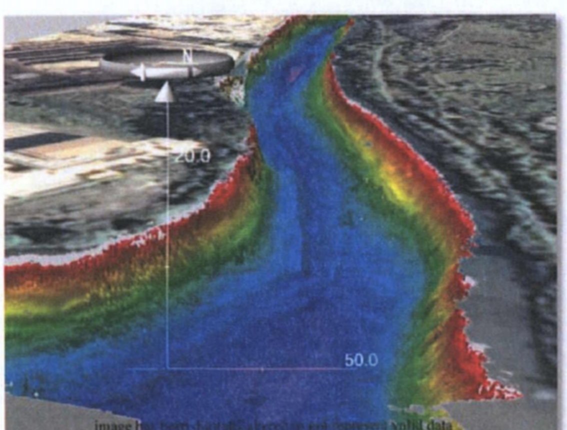
Affiliated Researchers LLC
Company Overview

Since 1990, Affiliated Researchers has provided environmental and technical services to a wide array of clientele including government agencies, municipalities, utility districts, and environmental-engineering firms. We are a certified HUBZone and a verified Service-disabled Veteran-owned small business, with our main office in Michigan and branch offices in California, and Virginia. Affiliated Researchers services are classified under NAICS codes: 541330; 541360; 541370; 541620; 541690; 541710; and 541990.

- **Biological Assessments**
  - Benthic Habitat Mapping
  - Benthic Invertebrate Sampling and Identification
  - Biological Inventories
  - Botanical Inventories
  - Fisheries Management Support
  - Invasive Species Inventories
  - Substrate Classification Surveying
  - Threatened & Endangered Species Inventories
  - Wetland-Riparian Delineations

- **Geotechnical**
  - Magnetometer Surveying
  - Sediment Trap Placement and Monitoring
  - Side-scan Sonar Surveying
  - Sub-bottom Profiling
  - Substrate Characterization and Mapping
  - Vibracore Sediment Sampling

- **Hydrographic Surveying**
  - Multi-beam Sonar Surveying
  - Pre- and Post-Dredging Surveying
  - Single-beam Sonar Surveying



- **Hydrology Investigations**
  - Acoustic Doppler Current Profiling
  - Reservoir Capacity Surveying and Calculation
  - Stream Bathymetric Surveying

- **Surveying and Mapping**
  - GPS-GIS Geospatial Mapping
  - Mobile LiDAR Surveying
  - RTK-GPS Topography and Features Surveying

- **Water Quality Investigations**
  - Water Quality Sampling and Monitoring
  - Water Quality Surveying
  - Water Temperature Surveying

Our experienced technical staff, advanced technology, proven methods, and quality equipment enable Affiliated Researchers to deliver effective solutions.

Please call our office to discuss how our services can support your project requirements.

Calculation Cover Sheet

AECOM

CALCULATION COVER PAGE

BASIC INFORMATION

Project	Job No.	TTP No. (if req'd)	Total pages includes attachments Page 1 of ______
Client	Department/Discipline		Calculation No.
Subject / Title			

Calculation Rev. No.	Originator	Discipline Reviewer	Technical Peer Reviewer (if req'd)	Confirmation Req'd Y/N

Calculation Objective:

Calculation Methodology and data to be confirmed:

References / Inputs/ Field Data:

Conclusions including confirmations to be obtained:

This calculation is complete and ready for Discipline Review:

Originator ______________________________
Signature / Date

Q4NA-331-FM4

Calculation Review Checklist

AECOM

CALCULATION REVIEW CHECKLIST

PROJECT		JOB NO.	
CLIENT	DISCIPLINE	CALCULATION NO. _______ REV. NO. _______	
SUBJECT/TITLE		TTP NO. (if used) _________	
ORIGINATOR		DISCIPLINE REVIEWER	
DISCIPLINE LEAD		INDEPENDENT CALCULATION PREPARER (if used)	

Discipline Review

	Yes	No	N/A
1. Is the calculation in accordance with a standard approach to preparing the design?	☐	☐	☐
2. Have input data and information been verified and accepted?	☐	☐	☐
3. Have assumptions requiring follow-up been reviewed and confirmed?	☐	☐	☐
4. Are the mathematics correct?	☐	☐	☐
5. Are results and conclusions consistent and reasonable considering the inputs and approach?	☐	☐	☐
6. Have the originator and the checker/reviewer signed and dated the calculation?	☐	☐	☐
7. Have all previous internal review comments been addressed and closed out with the originator?	☐	☐	☐
8. Have all previous client review comments been addressed and closed out?	☐	☐	☐

Explain "No" responses:

Discipline Reviewer ______________________________
Signature/Date

Independent Calculations (**in lieu of Discipline Review**)

A separate, independent set of calculations has been prepared, validating the original calculations.

Independent Calculation Preparer ______________________________
Signature/Date

Note: Independent Peer Reviews, where required, and Discipline Lead concurrence are recorded on the Deliverable Release Record (Q3NA-351-FM7) which is required for all deliverables.